NOAA Professional Paper NMFS 23

A guide to the corals of Alaska

Robert P. Stone
Stephen D. Cairns
Dennis M. Opresko
Gary C. Williams
Michele M. Masuda

December 2023

DEPARTMENT OF COMMERCE
UNITED STATES OF AMERICA

NOAA Professional Papers NMFS

U.S. Department of Commerce
Gina M. Raimondo
Secretary of Commerce

National Oceanic and Atmospheric Administration
Richard W. Spinrad
Administrator

National Marine Fisheries Service
Janet Coit
Assistant Administrator
for Fisheries

Scientific Editor
José I. Castro

National Marine Fisheries Service, NOAA
263 13th Avenue South
Saint Petersburg, Florida 33701

Associate Editor
Cara Mayo

National Marine Fisheries Service, NOAA
Scientific Publications Office
7600 Sand Point Way NE
Seattle, Washington 98115

Managing Editor
Shelley Arenas
National Marine Fisheries Service, NOAA
Scientific Publications Office
7600 Sand Point Way NE
Seattle, Washington 98115

The NOAA Professional Paper NMFS (ISSN 1931-4590) series is published by the Scientific Publications Office, National Marine Fisheries Service, NOAA, 7600 Sand Point Way NE, Seattle, WA 98115.

The Secretary of Commerce has determined that the publication of this series is necessary in the transaction of the public business required by law of this Department. Use of funds for printing of this series has been approved by the Director of the Office of Management and Budget.

The NOAA Professional Paper NMFS series carries peer-reviewed, lengthy original research reports, taxonomic keys, species synopses, flora and fauna studies, and data-intensive reports on investigations in fishery science, engineering, and economics. Copies of the NOAA Professional Paper NMFS series are available free in limited numbers to government agencies, both federal and state. They are also available in exchange for other scientific and technical publications in the marine sciences. Professional Papers are published online in PDF format at http://spo.nmfs.noaa.gov

NOAA Professional Paper NMFS 23

A guide to the corals of Alaska

Robert P. Stone (retired) (contact author)[1]
Stephen D. Cairns (retired)[2]
Dennis M. Opresko (retired)[2]
Gary C. Williams[3]
Michele M. Masuda[1]

[1] Auke Bay Laboratories
Alaska Fisheries Science Center
National Marine Fisheries Service, NOAA
17109 Point Lena Loop Road
Juneau, Alaska 99801
Present address for contact author: 3105 National Park Road
Juneau, Alaska 99801
Email: bob.stone.coral@gmail.com

[2] Department of Invertebrate Zoology
National Museum of Natural History
Smithsonian Institution
P.O. Box 37012, MRC 163
Washington, D.C. 20013-7012

[3] Department of Invertebrate Zoology and Geology
California Academy of Sciences
875 Howard Street
San Francisco, California 94103

December 2023

U.S. Department of Commerce
Seattle, Washington

Cover figure

Top left: A school of yellowtail rockfish (*Sebastes flavidus*) feeding in a thicket of *Primnoa pacifica* in Dixon Entrance (eastern Gulf of Alaska) at a depth of 165 m. Top right: Coral habitat dominated by bubblegum corals (*Paragorgia* sp.) on the flank of the submarine volcano Amchixtam Chaxsxii (central Aleutian Islands) at a depth of 920 m. Bottom left: A *Muriceides nigra* colony highlights a coral garden on the flank of the Bobrof Volcano (central Aleutian Islands) at a depth of 160 m. Bottom right: Coral habitat dominated by hydrocorals (mostly *Stylaster* sp.) in northern Amchitka Pass (central Aleutian Islands) at a depth of 896 m.

Suggested reference

Stone, Robert P., Stephen D. Cairns, Dennis M. Opresko, Gary C. Williams, and Michele M. Masuda. 2023. A guide to the corals of Alaska. NOAA Professional Paper NMFS 23, 413 p. https://doi.org/10.7755/PP.23

Online dissemination

This report is posted online in PDF format at https://spo.nmfs.noaa.gov (click on Professional Papers link).

Copyright law

Although the contents of the Professional Papers have not been copyrighted and may be reprinted entirely, reference to source is appreciated.

Proprietary products

The National Marine Fisheries Service (NMFS) does not approve, recommend, or endorse any proprietary product or proprietary material mentioned in this publication. No reference shall be made to NMFS, or to this publication furnished by NMFS, in any advertising or sales promotion which would indicate or imply that NMFS approves, recommends, or endorses any proprietary product or proprietary material mentioned herein, or which has as its purpose an intent to cause directly or indirectly the advertised product to be used or purchased because of this NMFS publication.

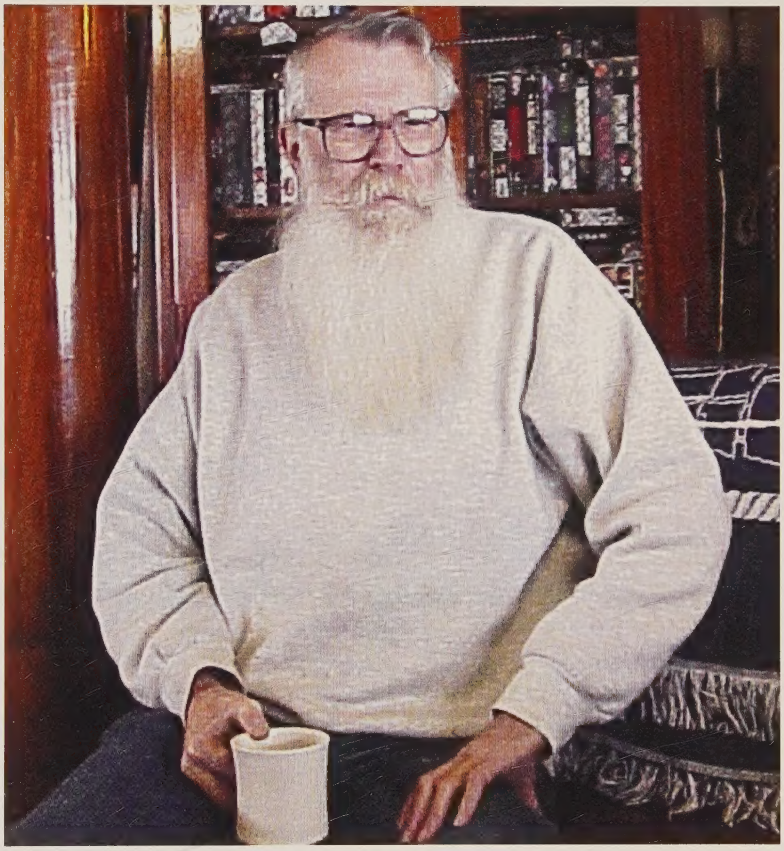
Disclaimer

The findings and conclusions in this report are those of the author(s) and do not necessarily represent the views of the National Marine Fisheries Service (NOAA).

We dedicate this guide in memory of

Bruce L. Wing

1938 – 2016



"Only as a biological oceanographer can one expect
to work on whales, turtles, fish, zooplankton,
phytoplankton, bacteria, water chemistry,
ocean physics, [and deep-sea corals], sometimes all in one day."

CONTENTS

Chapter 1 – Introduction 1
  About this guide 2
  Alaska – physiography 5
    Eastern Gulf of Alaska 5
    Western Gulf of Alaska 5
    Gulf of Alaska Seamount Province 5
    Aleutian Islands 6
    Bering Sea 7
    Alaska Arctic 7
  Data sources 8
  Alaska corals – inventory and systematics 8
  Zoogeography of corals 9
  Collection and preservation of specimens 10
Chapter 2 – Class Anthozoa, Subclass Hexacorallia, Order Antipatharia 12
Chapter 3 – Order Scleractinia 54
Chapter 4 – Order Zoantharia 76
Chapter 5 – Subclass Octocorallia, Order Malacalcyonacea, Family Alcyoniidae 88
Chapter 6 – Family Clavulariidae 104
Chapter 7 – Family Gorgoniidae 111
Chapter 8 – Family Malacalcyonacea *incertae sedis* 118
Chapter 9 – Family Paramuriceidae 140
Chapter 10 – Order Scleralcyonacea, Family Chrysogorgiidae 150
Chapter 11 – Family Coralliidae 167
Chapter 12 – Family Keratoisididae 200
Chapter 13 – Family Primnoidae 233
Chapter 14 – Family Sarcodictyonidae 292
Chapter 15 – Superfamily Pennatuloidea 297
Chapter 16 – Class Hydrozoa, Order Anthoathecata, Family Stylasteridae 341
Acknowledgments 391
Literature cited 392
Appendix I. Glossary 401
Appendix II. Coral species reported from Alaska waters 409
Appendix III. Additional supporting references on Alaska corals 413

Digitized by the Internet Archive
in 2025

https://archive.org/details/noaa-professional-paper_2023-12_23

Abstract—The Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 mandated the research and management of the nation's deep-sea coral resources through establishment of the National Oceanic and Atmospheric Administration's Deep Sea Coral Research and Technology Program. The challenge for Alaska was daunting, where expansive, world-class fisheries often coincided with extraordinarily rich coral habitats for a high-latitude region. The first challenge was to inventory known locations of deep-sea corals. Many coral records and some museum collections existed from Alaska, but the taxonomy of corals was little studied and field identification of corals was problematic. Formal bycatch programs and research activities in recent decades provided many more specimens for taxonomic study, but guides to species were largely incomplete, inaccurate, and outdated given the fast pace of species discovery in Alaska. We provide a comprehensive, up-to-date guide, detailing 161 coral taxa identified from museum collections, primary literature, and video records. Each profile includes a description, images for each taxon, taxonomic history, biology, ecology, geographical distribution, and habitat, including depth distribution. Corals are found in the six regions of Alaska but the coral fauna of the Aleutian Islands is by far the most species rich. The state of taxonomy for some coral groups is excellent, while others require additional collections and more taxonomic work. Construction of this guide resulted in descriptions of several antipatharian species, published separately from this guide (*Alternatipathes mirabilis*, *Bathypathes alaskensis*, *B. ptiloides*, *B. tiburonae*, and *Parantipathes pluma*) and the scleractinian *Flabellum* (*Flabellum*) *oclairi* Cairns, sp. nov. described herein. The guide provides information for targeting new collections and identifying areas of high abundance and indicator species of vulnerable marine ecosystems. Stakeholders can now more adequately assess Alaska's coral resources and risks from natural and anthropogenic stressors.

CHAPTER 1

Introduction

For more than a century Alaskan fishermen have inadvertently brought corals to the sea surface tangled in nets and lines, and early on the corals became symbolic of the rich fauna and diverse communities in deep marine waters there (Fig. 1-1). A few coral species from Alaska waters were described in the late 1800s (Verrill, 1866; Dall, 1884), but scientists paid little attention to the region's coral resources until the U.S. Fisheries Steamer *Albatross* returned from Alaska with astonishing evidence of rich coral beds. The U.S. Fisheries Steamer *Albatross* expeditions continued through 1906, and collections made during that period prompted the first detailed work on Alaska octocorals (Nutting, 1912) and hydrocorals (Fisher, 1938). With specific regard to hydrocorals, Fisher (1938) noted "the North Pacific is far richer in indigenous species than the North Atlantic." Opportunistic and directed collections made during expeditions in the latter 1900s provided for subsequent taxonomic work on octocorals (Bayer, 1952a, 1996; Cairns, 2011a), antipatharians (Opresko, 2005), stylasterids (Cairns and Lindner, 2011), and a synthesis on scleractinians (Cairns, 1994).

Despite early evidence that Alaska had surprisingly vast coral resources for a high-latitude area of the world, corals remained little more than curios until the U.S. Congress enacted amendments to the Magnuson-Stevens Fishery Conservation and Management Act in 1996. Known as the Sustainable Fisheries Act, the legislation placed emphasis on the impacts of fisheries on essential fish habitat and launched a new wave of exploration, including research using submersibles and remotely operated vehicles to gather glimpses of Alaska's coral habitats for the first time. Discovery of vast coral resources in the Aleutian Islands (Stone, 2006; Stone and Shotwell, 2007; Stone, 2014), Gulf of Alaska (GOA) Seamounts (Baco, 2007), and elsewhere in the United States (Lumsden et al., 2007) greatly informed several important mandates of the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006. The Reauthorization Act established the National Oceanic and Atmospheric Administration's Deep Sea Coral Research and Technology Program with specific mandates to conduct research and manage deep-sea coral resources.

One of the major objectives of the Deep Sea Coral Research and Technology Program was to inventory locations of deep-sea corals. In Alaska, researchers mapped known locations of all coral records to identify "hot spots" or areas where corals appeared to be particularly diverse and/or abundant (see Stone and Rooper, 2017). These locations were prioritized for in situ exploration. Since bycatch in fisheries and fisheries-independent surveys is a major source of information on the location of coral fauna and a source of specimens for study, programs were implemented to increase the awareness and ability of fisheries observers and scientists to collect bycatch specimens for museum collections and taxonomic study (Stone et al., 2015a). A few guides were available for use in the field (Wing

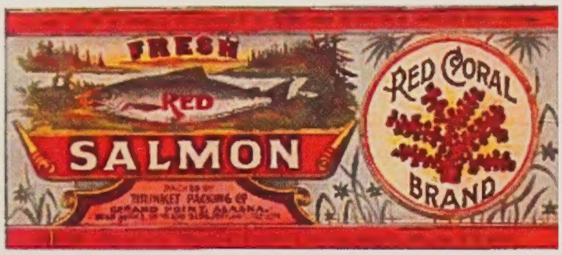


Figure 1-1

A canned sockeye salmon label (circa 1889) used by the Thlinket Packing Company located on Wrangell Island, Alaska during the earliest days of commercial fishing operations in the state. The label pays homage to the fishermen's familiarity with the thickets of red tree coral (*Primnoa pacifica*) on the nearby fishing grounds.

and Barnard, 2004; Clark[1]) and have been an important first step toward adequately monitoring coral bycatch, but were quickly outdated given the fast pace of discovery in a largely unexplored region. The available guides are largely incomplete, contain species that have never been confirmed to occur in Alaska waters, and use inaccurate taxonomic nomenclature.

Here, we provide a comprehensive and up-to-date guide for the identification of Alaska corals. The main purpose of this guide is to develop an awareness and appreciation of the importance of the coral fauna in Alaska waters, where the diversity and abundance of corals is extraordinary and bycatch in existing fisheries continues to be a major concern for resource managers. This guide allows fisheries observers and scientists to identify corals so that more accurate data can be included in existing databases. The guide is also designed for use by scientists making observations of the fauna in situ with submersibles, including remotely operated vehicles, autonomous underwater vehicles, and towed camera systems (e.g., Goddard et al., 2016). These in situ observations are critical to identify areas of high abundance and the locations of indicator species of vulnerable marine ecosystems such as coral gardens. We provide detailed profiles for 161 coral taxa.

About this guide

This guide brings together all known information for every coral taxon in Alaska. It is intended as a companion reference to "A guide to the deep-water sponges of the Aleutian Island Archipelago" (Stone et al., 2011) to assist in identifying the rich benthic fauna of Alaska. We provide detailed profiles for all coral taxa that we have identified from museum collections, the primary literature, and detailed analysis of high-confidence video records. Altogether, we present 15 coral chapters arranged systematically (Table 1): each of the three orders of Hexacorallia (Antipatharia, Scleractinia, and Zoantharia); each of the 10 families of Octocorallia (Alcyoniidae, Clavulariidae, Gorgoniidae, Malacalcyonacea *incertae sedis*, Paramuriceidae, Chrysogorgiidae, Coralliidae, Keratoisididae, Primnoidae, and Sarcodictyonidae), given their relatively high species richness, abundance, and ecological importance; the superfamily Pennatuloidea; and the family Stylasteridae.

Each coral chapter begins with a summary of taxonomic and systematic notes, biological and ecological information, and figure(s) illustrating basic morphological features. In Appendix I we provide a glossary of common terms subdivided by major taxonomic group (order Antipatharia, order Scleractinia, order Zoantharia, subclass Octocorallia, superfamily Pennatuloidea, and family Stylasteridae). We refer the reader to publications by Cairns and Kitahara (2012), Bayer et al. (1983), Williams (1995), and Cairns (2011a) for additional keys, illustrations, and glossaries for morphological and anatomical terms applied to Scleractinia (azooxanthellate), Octocorallia, Pennatuloidea, and Stylasteridae, respectively.

We present scientific names using standard binominal nomenclature. The first name (always capitalized) is the genus (e.g., *Stylaster*). The second name (never capitalized) is the species (e.g., *parageus*). A few species have a third name (never capitalized) for a designated subspecies (e.g., *columbiensis*), and a few others have additional designations (never capitalized) for a variant (var.) or morph. Additionally, five species in this guide from the order Scleractinia have a designated subgenus that is identified with parentheses and placed between the genus and species (e.g., *Fungiacyathus* (*Bathyactis*) *marenzelleri*). The authority or name(s) of the author(s) of the species description (i.e., the person[s] who described the species) and year of description follow the scientific name. Parentheses placed around the authority indicate there has been an accepted transfer to a different genus since the original description.

Each profile begins with a description including 1) typical growth form(s), 2) branching patterns, 3) known size range or maximum dimensions, 4) surface morphology, 5) axial skeletal and holdfast characteristics, 6) characteristics of the polyps and other surficial features, 7) fragility, and 8) color in life and with various preservation methods. For many taxa, examination of these characteristics can provide a fairly accurate iden-

---

[1] Clark, R. N. 2006. Field guide to the benthic marine invertebrates of Alaska's shelf and upper slope taken by NOAA/NMFS/AFSC/RACE Division trawl surveys, 305 p. Unpubl. manuscript. Alaska Fish. Sci. Cent., Natl. Mar. Fish. Serv., 7600 Sand Point Way NE, Seattle, WA 98115.

Table 1

Systematics for all coral taxa currently known to occur in Alaska waters. The taxonomic names are all modern, systematically arranged to family, and alphabetically arranged by genus and species within each family. Scientific names are presented using standard binominal nomenclature. The authority or name(s) of the author(s) of the species description (i.e., the person[s] who described the species) and year of description follow the scientific name. Parentheses placed around the authority indicate there has been an accepted transfer to genus assignment since the original description. We used the World Register of Marine Species as the taxonomic authority.

PHYLUM CNIDARIA

- CLASS ANTHOZOA
  - Subclass Hexacorallia
    - Order Antipatharia
      - Family Cladopathidae
        - *Chrysopathes formosa* Opresko, 2003
        - *Chrysopathes speciosa* Opresko, 2003
        - *Heteropathes pacifica* (Opresko, 2005)
        - *Trissopathes pseudotristicha* Opresko, 2003
      - Family Schizopathidae
        - *Alternatipathes mirabilis* Opresko and Molodtsova, 2021
        - *Bathypathes alaskensis* Opresko and Molodtsova, 2021
        - *Bathypathes patula* Brook, 1889
        - *Bathypathes ptiloides* Opresko and Molodtsova, 2021
        - *Bathypathes tiburonae* Opresko and Molodtsova, 2021
        - *Bathypathes* sp. A
        - *Bathypathes* sp. B
        - *Dendrobathypathes boutillieri* Opresko, 2005
        - *Dendrobathypathes* sp.
        - *Lillipathes wingi* Opresko, 2005
        - *Lillipathes* sp. A
        - *Parantipathes euantha* (Pasternak, 1958)
        - *Parantipathes pluma* Opresko and Molodtsova, 2021
        - *Parantipathes* sp. A
    - Order Scleractinia
      - Family Caryophylliidae
        - *Caryophyllia* (*Caryophyllia*) *alaskensis* Vaughan, 1941
        - *Caryophyllia* (*Caryophyllia*) *arnoldi* Vaughan, 1900
        - *Crispatotrochus foxi* (Durham and Barnard, 1952)
        - *Desmophyllum dianthus* (Esper, 1794)
      - Family Dendrophylliidae
        - *Balanophyllia* (*Balanophyllia*) *elegans* Verrill, 1864
      - Family Flabellidae
        - *Flabellum* (*Flabellum*) *oclairi* Cairns, sp. nov.
        - *Javania borealis* Cairns, 1994
        - *Javania cailleti* (Duchassaing and Michelotti, 1864)
      - Family Fungiacyathidae
        - *Fungiacyathus* (*Bathyactis*) *marenzelleri* (Vaughan, 1906)
      - Family Micrabaciidae
        - *Leptopenus discus* Moseley, 1880
    - Order Zoantharia
      - Family Epizoanthidae
        - *Epizoanthus scotinus* Wood, 1957
      - Family Parazoanthidae
        - *Mesozoanthus* sp.
        - *Zibrowius* cf. *ammophilus*
        - gen. nov., sp. nov.
  - Subclass Octocorallia
    - Order Malacalcyonacea
      - Family Alcyoniidae
        - *Alcyonium pacificum* Yamada, 1950
        - *Alcyonium* sp.
        - *Gersemia fruticosa* (Sars, 1860)
        - *Gersemia lambi* Williams, 2013
        - *Gersemia rubiformis* (Ehrenberg, 1834)
        - *Gersemia* sp.
      - Family Clavulariidae
        - *Clavularia armata* Thomson, 1927
        - *Clavularia eburnea* Kükenthal, 1906
        - *Clavularia rigida* Broch, 1935
        - *Clavularia* sp. A
      - Family Gorgoniidae
        - *Callistephanus pacificus* Nutting, 1912
        - *Callistephanus simplex* (Nutting, 1909)
      - Family Malacalcyonacea *incertae sedis*
        - *Alaskagorgia aleutiana* Sánchez and Cairns, 2004
        - *Alaskagorgia splendicitrina* Horvath and Stone, 2018
        - *Calcigorgia beringi* (Nutting, 1912)
        - *Calcigorgia gigantea* Matsumoto et al., 2019
        - *Calcigorgia japonica* Dautova, 2007
        - *Calcigorgia matua* Dautova, 2018
        - *Calcigorgia spiculifera* Broch, 1935
        - *Cryogorgia koolsae* Williams, 2005
        - *Elenanthus* cf. *violaceus*
      - Family Paramuriceidae
        - *Acanthogorgia spissa* Kükenthal, 1908
        - *Acanthogorgia* sp.
        - *Muriceides cylindrica* Nutting, 1912
        - *Muriceides nigra* Nutting, 1912
    - Order Scleralcyonacea
      - Family Chrysogorgiidae
        - *Chrysogorgia* sp. A
        - *Chrysogorgia* sp. B
        - *Chrysogorgia* sp. C
        - *Pseudochrysogorgia* sp. A
        - *Pseudochrysogorgia* sp. B
        - *Pseudochrysogorgia* sp. C
        - *Radicipes stonei* Cordeiro et al., 2017
      - Family Coralliidae
        - *Hemicorallium* sp.
        - *Paragorgia jamesi* Herrera and Shank, 2016
        - *Paragorgia arborea* var. *pacifica* Verrill, 1922
        - *Paragorgia arborea* var. *pacifica* morph *nodosa*
        - *Paragorgia stephencairnsi* Sánchez, 2005
        - *Paragorgia* sp. A
        - *Paragorgia* sp. B
        - *Sibogagorgia cauliflora* Herrera et al., 2010

Table continued

Table 1 (continued)

      - Subfamily Anthomastinae
        - *Heteropolypus japonicus* (Nutting, 1912)
        - *Heteropolypus ritteri* (Nutting, 1909)
        - *Heteropolypus* sp.
        - *Pseudoanthomastus* sp.
    - Family Keratoisididae
      - *Bathygorgia profunda* Wright, 1885
      - *Bathygorgia* sp. A
      - *Isidella tentaculum* Etnoyer, 2008
      - *Isidella* sp. A
      - *Isidella* sp. B
      - *Keratoisis* sp. A
      - *Keratoisis* sp. B
      - *Keratoisis* sp. C
      - *Keratoisis* sp. D
      - *Keratoisis* sp. E
      - *Keratoisis* sp. F
      - *Keratoisis* sp. G
      - *Orstomisis* sp.
    - Family Primnoidae
      - *Arthrogorgia kinoshitai* Bayer, 1952
      - *Arthrogorgia otsukai* Bayer, 1952
      - *Arthrogorgia utinomii* Bayer, 1996
      - *Callogorgia compressa* (Verrill, 1865)
      - *Callogorgia fraseri* (Hickson, 1915)
      - *Calyptrophora laevispinosa* Cairns, 2007
      - *Narella abyssalis* Cairns and Baco, 2007
      - *Narella alaskensis* Cairns and Baco, 2007
      - *Narella arbuscula* Cairns and Baco, 2007
      - *Narella bayeri* Cairns and Baco, 2007
      - *Narella cristata* Cairns and Baco, 2007
      - *Parastenella doederleini* (Wright and Studer, 1889)
      - *Parastenella gymnogaster* Cairns, 2007
      - *Parastenella ramosa* (Studer, 1894)
      - *Plumarella aleutiana* Cairns, 2011
      - *Plumarella echinata* Cairns, 2011
      - *Plumarella hapala* Cairns, 2011
      - *Plumarella nuttingi* Cairns, 2011
      - *Plumarella profunda* Cairns, 2011
      - *Plumarella robusta* Cairns, 2011
      - *Plumarella spicata* Nutting, 1912
      - *Plumarella superba* (Nutting, 1912)
      - *Primnoa pacifica* Kinoshita, 1907
      - *Primnoa pacifica* var. *willeyi* (Hickson, 1915)
      - *Primnoa wingi* Cairns and Bayer, 2005
      - *Thouarella cristata* Cairns, 2011
      - *Thouarella trilineata* Cairns, 2011
    - Family Sarcodictyonidae
      - *Sarcodictyon incrustans* (Broch, 1935)
      - *Sarcodictyon* sp. A
  - Superfamily Pennatuloidea
    - Family Anthoptilidae
      - *Anthoptilum grandiflorum* (Verrill, 1879)
      - *Anthoptilum murrayi* Kölliker, 1880
    - Family Anthoptilidae (cont.)
      - *Anthoptilum* sp. A
      - *Anthoptilum* sp. B
      - *Anthoptilum* sp. C
      - *Anthoptilum* sp. D
    - Family Balticinidae
      - *Balticina californica* (Moroff, 1902)
      - *Balticina willemoesi* (Kölliker, 1880)
      - *Balticina* sp. A
    - Family Kophobelemnidae
      - *Kophobelemnon* sp.
    - Family Pennatulidae
      - *Pennatula aculeata* Danielssen, 1860
      - *Pennatula* sp.
      - *Ptilosarcus gurneyi* (Gray, 1860)
    - Family Protoptilidae
      - *Protoptilum* sp.
    - Family Stachyptilidae
      - *Stachyptilum superbum* Studer, 1894
    - Family Umbellulidae
      - *Umbellula* sp.
    - Family Veretillidae
      - *Cavernularia vansyoci* Williams, 2005
    - Family Virgulariidae
      - *Virgularia bromleyi* Kölliker, 1880
      - *Virgularia* cf. *bromleyi*
      - *Virgularia* cf. *glacialis*
- CLASS HYDROZOA
  - Order Anthoathecata
    - Family Stylasteridae
      - *Crypthelia trophostega* Fisher, 1938
      - *Cyclohelia lamellata* Cairns, 1991
      - *Distichopora borealis* Fisher, 1938
      - *Errinopora dichotoma* Lindner and Cairns, 2011
      - *Errinopora disticha* Lindner and Cairns, 2011
      - *Errinopora fisheri* Lindner and Cairns, 2011
      - *Errinopora nanneca* Fisher, 1938
      - *Errinopora undulata* Lindner and Cairns, 2011
      - *Errinopora zarhyncha* Fisher, 1938
      - *Stylantheca papillosa* (Dall, 1884)
      - *Stylaster alaskanus* Fisher, 1938
      - *Stylaster brochi* (Fisher, 1938)
      - *Stylaster campylecus* (Fisher, 1938)
      - *Stylaster crassiseptum* Cairns and Lindner, 2011
      - *Stylaster elassotomus* Fisher, 1938
      - *Stylaster leptostylus* (Fisher, 1938)
      - *Stylaster parageus columbiensis* Cairns and Lindner, 2011
      - *Stylaster parageus parageus* (Fisher, 1938)
      - *Stylaster repandus* Cairns and Lindner, 2011
      - *Stylaster stejnegeri* (Fisher, 1938)
      - *Stylaster trachystomus* (Fisher, 1938)
      - *Stylaster venustus* (Verrill, 1868)
      - *Stylaster verrillii* (Dall, 1884)

tification. Definitive identification of most species, however, requires careful examination of the arrangement of microscopic skeletal structures, particularly the types, sizes, and locations of sclerites, and we provide that information in each profile if available.

For most taxa, we provide images of fresh or live specimens, preserved museum specimens, and specimens in situ. The former would be most useful to those identifying specimens on the deck of fishing and survey vessels while the latter would be useful to scientists attempting to identify and quantify coral fauna in situ with submersibles and remotely operated vehicles or from video footage collected in situ. We provide the known geographic range and information on the physical habitat, including depth, substrate, and associated fauna of each species both within Alaska waters and throughout its known range. The geographic range in Alaska for each taxon is depicted and finally, we include special remarks with regard to taxonomic history, biology, and ecology.

Appendix II provides a current and comprehensive taxonomic list of all coral taxa known to occur in Alaska. The list highlights the regions of occurrence and reported depth range for each taxon. Appendix III provides a list of additional references not cited in the chapters that may provide the curious reader with valuable information on Alaska corals.

Alaska – physiography

Alaska forms a large portion of the northern margin of the North Pacific Ocean and contains the majority of the U.S. marine coastline and continental shelf habitat. The region has a highly varied submarine bathymetry, owing to the numerous physical and geological processes at work in the three main physiographic provinces—the GOA, the Bering Sea including the Aleutian Island Archipelago, and the Chukchi and Beaufort Seas in the Alaska Arctic. For the purposes of this guide, however, we delineate six distinct regions (Fig. 1-2) of Alaska that have been used in previous reports on the distribution of marine resources (Stone and Shotwell, 2007; Stone and Rooper, 2017) and more-or-less conform to resource management regions in the state. Those are 1) the eastern GOA, 2) the western GOA, 3) the GOA Seamount Province (GOASP), 4) the Aleutian Islands, 5) the Bering Sea, and 6) the Alaska Arctic.

Eastern Gulf of Alaska

The eastern GOA region is delineated by Dixon Entrance on the state's southern border with British Columbia (Canada) and the line of longitude 146°W near the central part of Prince William Sound and includes the Inside Waters of Southeast Alaska (Fig. 1-2). In this region, the Pacific Plate moves roughly parallel to the North American Plate along the Fairweather-Queen Charlotte Fault, forming an abrupt continental slope with an abbreviated shelf (von Huene, 1989). Prominent geological features of the region include the Fairweather Ground, a large offshore shoal on the outer edge of the continental shelf in the northeast GOA, and the Shutter Ridge located 28 km west of Cape Ommaney, Baranof Island, on the continental shelf. The ridge comprises a series of rocky pinnacles along a subduction zone where the Pacific Plate has docked with Alaska (Greene[2]).

Western Gulf of Alaska

The western GOA region is delineated from longitude 146°W to longitude 163°W, near the east end of Unimak Island, the first Island in the Aleutian Island Archipelago (Fig. 1-2). The western GOA has a broad continental shelf extending seaward up to 200 km in some areas and contains several deep troughs (NRC, 1990). The region includes smooth turbidity sediment scapes, methane seeps, areas strongly influenced by glaciation, and large basins with high rates of sedimentation (Reece et al., 2011). In this region the Pacific and North American plates slide, rather than slip, past each other and form a convergent margin and subduction zone (von Huene, 1989).

Gulf of Alaska Seamount Province

The GOASP is far offshore and encompasses a large area from near the Aleutian Trench to the Juan de Fuca Ridge off Washington. The province contains over 100 volcanic seamounts (>1000 m in height) arranged in two volcanic chains. The Kodiak–Bowie chain spans 900 km from Kodiak Seamount in the western GOA to Bowie Seamount off the Queen Charlotte Islands (British Columbia) and contains 14 major and numerous minor seamounts (Chaytor et al., 2007), most of which were formed by movement of the Pacific Plate over the Bowie hot spot (Turner et al., 1973). The Cobb Seamount chain extends from Marchand Seamount in the northwestern GOA to Axial Seamount off the coast of Oregon (Chaytor et al., 2007) where the Cobb hot spot is currently located on the Juan de Fuca Ridge (Desonie and Duncan, 1990).

The 24 seamounts in Alaska waters span the entire GOA from Dickens Seamount in the southeastern sector to Derickson Seamount in the western sector (Fig. 1-2). Sixteen of those seamounts summit within the range of managed or targeted fish species and were designated as Habitat Areas of Particular Concern in 2007 by the

---

[2] Greene, G. 2014. Personal commun. Univ. Calif., 1850 Research Park Dr., Suite 300, Davis, CA 95618–6134.

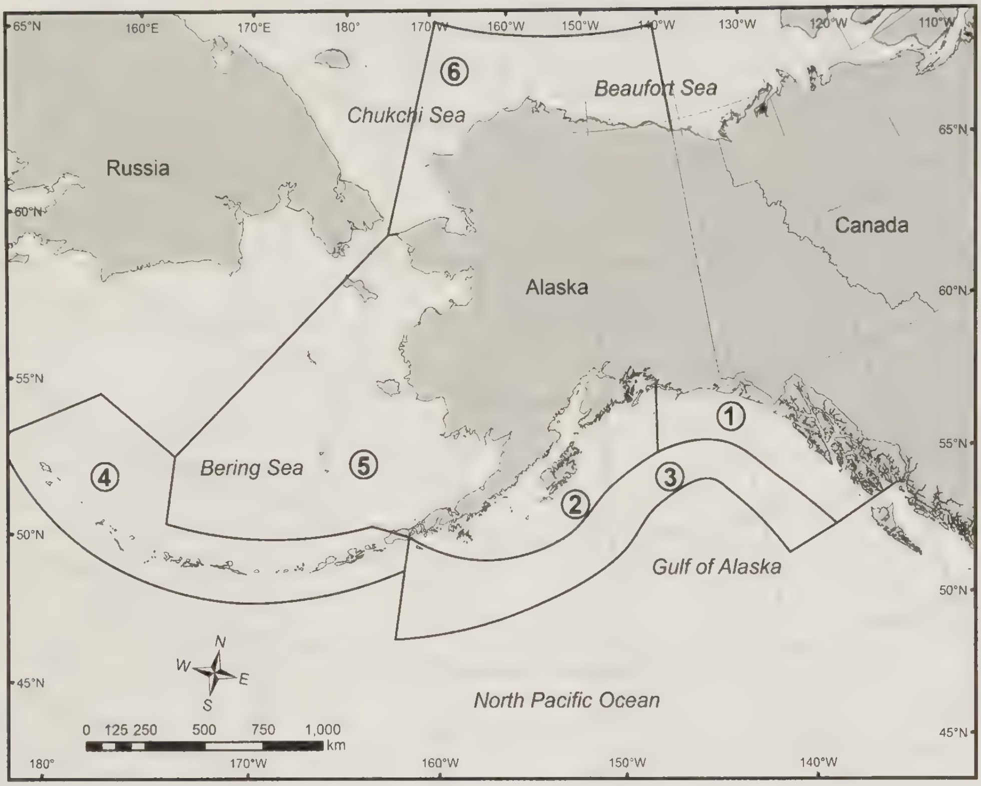


Figure 1-2

A map of the Alaska region showing the six broad geographical areas used in this guide: eastern Gulf of Alaska (Region 1), western Gulf of Alaska (Region 2), Gulf of Alaska Seamount Province (Region 3), Aleutian Islands (Region 4), eastern Bering Sea (Region 5), and Alaska Arctic, including the Chukchi and Beaufort Seas (Region 6). These geographical areas were delineated for previous zoogeographical compilations on the distribution of marine resources (e.g., Stone and Rooper, 2017).

North Pacific Fishery Management Council specifically to protect deep-sea coral habitat from disturbance by fishing gear (Stone and Shotwell, 2007). The majority of the seamounts have not yet been explored, but in this guide we include coral records and video observations made on nine of those seamounts. We also include records and observations from Pratt, Surveyor, and Murray Seamounts, which summit in international waters but lie near the boundary with Alaska (Fig. 1-3).

Aleutian Islands

The Aleutian Islands region is delineated by the line of longitude 163°W near the east end of Unimak Island to the international boundary with Russia west of Stalemate Bank, and south to the boundary with international waters (Fig. 1-2). To the north, the region encompasses all seafloor associated with the island arc slope of the archipelago (Fig. 1-2). The Aleutian Island Archipelago extends over 1900 km from the Alaska Peninsula to near the Kamchatka Peninsula in Russia and is supported by the Aleutian Ridge, which largely separates the deep North Pacific Ocean to the south and the shallower Bering Sea to the north. The Aleutian Ridge is a volcanic arc that contains more than 300 islands, including more than 20 active volcanoes.

The region has frequent earthquakes and was formed along zones of convergence between the North American Plate and other oceanic plates (Vallier et al., 1994). The island arc shelf is very narrow in the Aleutian Islands, drops precipitously on the Pacific side to depths greater than 6000 m in the Aleutian Trench, and contains several large canyons, most notably, Adak and Murray Canyons. A prominent feature of the Archipelago is Bowers Ridge, which projects northward in a 700-km arc from the central Aleutian Islands at Petrel Bank and along Bowers Bank to near the Ulm Plateau in the Aleutian Basin of the Bering Sea. Another notable geological feature of the region is Amchixtam Chaxsxii,

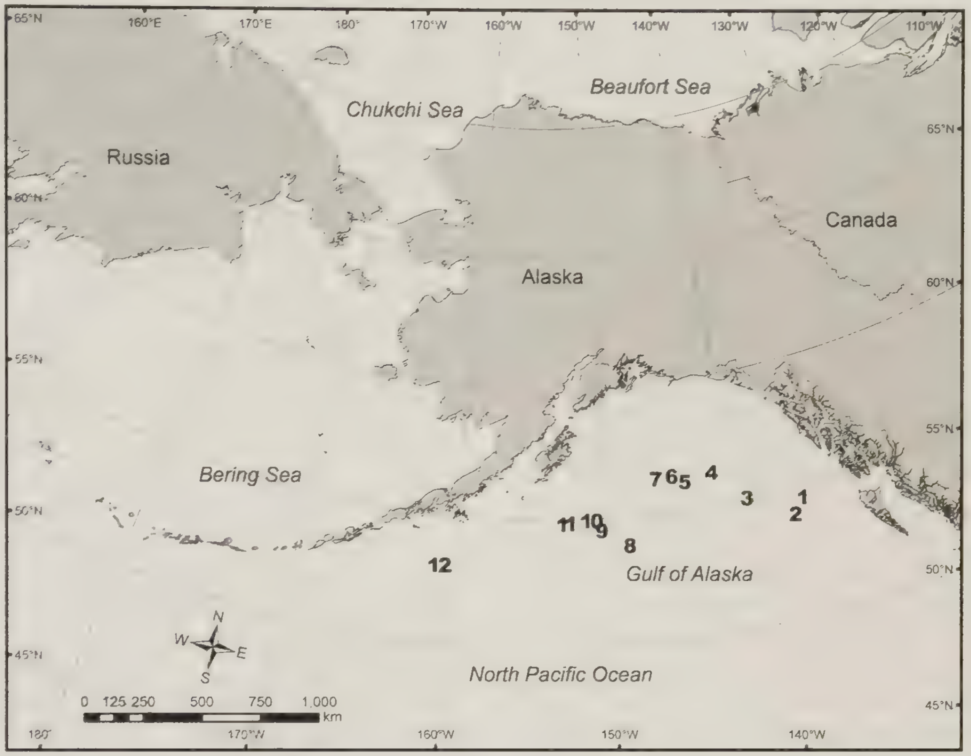


Figure 1-3

A map of the seamounts in the Gulf of Alaska Seamount Province where coral specimens and observations were collected: 1) Dickens Seamount, 2) Densen Seamount, 3) Welker Seamount, 4) Pratt Seamount, 5) Surveyor Seamount, 6) Quinn Seamount, 7) Giacomini Seamount, 8) Murray Seamount, 9) Patton Seamount, 10) Marchand Seamount, 11) Chirikof Seamount, and 12) Derickson Seamount. Historical (pre-1980) and recent research expeditions and National Marine Fisheries stock assessment surveys were a major source of coral specimens. Recent research expeditions were also an important source of video records.

a nearly perfect conical submarine volcano discovered in northern Amchitka Pass in 2002 that is largely covered with the most lush and expansive coral gardens known in Alaska (Stone, 2006, 2014).

Bering Sea

The Bering Sea region is bounded by the Aleutian Island Archipelago to the south, the Bering Strait to the north, and the boundary of territorial waters with Russia to the west (Fig. 1-2). The Bering Sea is a shallow sea with a massive continental shelf (1200 km long and 500 km wide)—one of the largest continental shelves in the world (NRC, 1990). The continental shelf breaks at approximately 170 m depth. Seven major canyons incise the continental slope, including the Zhemchug and Bering Canyons—the two largest submarine canyons in the world (Johnson, 2003; Normark and Carlson, 2003). The continental shelf and much of the slope contain limited hard substrate but are rather heavily covered with sediment deposited by the region's major rivers (Johnson, 2003).

Alaska Arctic

The Alaska Arctic region is confined by the Bering Strait to the south, the boundary of territorial waters with Russia to the west, the boundary with international waters to the north, and the line of longitude 141°W near the boundary with the Yukon Territory (Canada) to the east (Fig. 1-2). The region contains large areas of the Chukchi and Beaufort Seas. The Chukchi Sea is a relatively uniform, massive shallow shelf (only 20–60 m deep) whereas the Beaufort Sea is a submarine extension of the North Slope coastal plain consisting of a fairly broad (80–140 km wide) continental shelf and a steep precipitous slope into the abyss of the Beaufort Sea basin (Horowitz, 2002). Sediments on the continental shelf are predominantly soft and fine-grained and are redistributed by longshore currents, wave action, entrainment in bottom-fast ice, ice gouging, ocean currents, and internal waves (Horowitz, 2002). A prominent geological feature of the Beaufort Sea is the Stefansson Sound Boulder Patch, an area of isolated hard rock in an otherwise heavily sedimented region.

Data sources

All museum coral records from Alaska with appropriate geospatial data were inventoried and inspected for data quality. The majority of coral specimens collected in Alaska are archived at the National Museum of Natural History (NMNH; Smithsonian Institution, Washington, D.C.) previously known as the U.S. Museum of Natural History (USNM) and the California Academy of Sciences (CAS; San Francisco, California). A few Alaska records were obtained from the Royal British Columbia Museum (RBCM; Victoria, British Columbia, Canada), the Natural History Museum of London (NHMUK; London), and the Santa Barbara Museum of Natural History (SBMNH; Santa Barbara, California). We used the World Register of Marine Species (WoRMS Editorial Board, 2022) as the taxonomic authority and have mostly adopted the recently revised systematics of the Octocorallia based largely on phylogenomics (McFadden et al., 2022).

The majority of Alaska museum specimens have been collected during National Marine Fisheries Service stock assessment surveys, using longlines (Auke Bay Laboratories) and trawls (Resource Assessment and Conservation Engineering Division's Groundfish Assessment Program), and typically the location and depth are recorded as either the start or end point of the longline set or trawl haul. For both types of surveys, the start and end locations may vary by >10 km and the depth may span up to 400 m. To minimize the error associated with these records, we averaged the start and end values for both location and depth and present mean values. In no case did this method establish a new depth range for any species.

Both the Auke Bay Laboratories and Resource Assessment and Conservation Engineering Division's stock assessment programs maintain databases of coral bycatch records. However, because specimens are only retained upon special request and field identifications are typically made only at higher taxonomic levels, we did not consider them in our analysis. Curious fishermen and recreationists also occasionally retain coral specimens and donate them to laboratories for identification. Many of those specimens have proved valuable since they are often collected in areas not typically surveyed by the other methods.

In addition to historical collections like those from the U.S. Fisheries Steamer *Albatross* expeditions, National Marine Fisheries Service stock assessment surveys, and various fisheries, many coral records are available from past research expeditions made throughout Alaska. Many of these expeditions included video surveys of the seafloor and the intentional collection of unknown specimens, particularly those that were common or abundant and presumably ecologically important, and conversely those that appeared to be quite uncommon and unusual. Detailed examination in the laboratory of video footage coupled with expertly identified voucher specimens provided a wealth of high-confidence identifications and ecological observations.

Previous research expeditions that contributed high-confidence coral observations included those in 1) the eastern GOA, Southeast Alaska, and Portland Canal (Stone et al., 2013); 2) the eastern GOA continental shelf and slope (Stone et al., 2015b); 3) the western GOA continental shelf (Stone et al., 2005); 4) the central Aleutian Islands island arc shelf and slope (Stone, 2006, 2014); and 5) the eastern Bering Sea shelf and slope (Miller et al., 2012). Additionally, to provide a wealth of new coral observations we carefully examined archived video footage from four expeditions on seamounts in the GOASP in 2002, 2004, and 2019. The vast video library maintained at the National Oceanic and Atmospheric Administration Auke Bay Laboratories was also examined for high-confidence coral records, as were the detailed observations made by the senior author during more than 2000 scuba dives throughout much of Alaska between 1987 and 2017.

Alaska corals – inventory and systematics

Our comprehensive inventory indicates there are currently 161 distinct coral taxa known in Alaska (Table 1). The inventory includes two subclasses (Hexacorallia and Octocorallia) of Anthozoa and a single order (Anthoathecata) of Hydrozoa. The Hexacorallia includes the orders Antipatharia, Scleractinia, and Zoantharia. The Antipatharia includes two families: Cladopathidae (four taxa) and Schizopathidae (14 taxa). The Scleractinia includes five families: Caryophylliidae (four taxa), Dendrophylliidae (one taxon), Flabellidae (three taxa including *Flabellum* (*Flabellum*) *oclairi* Cairns, sp. nov.), Fungiacyathidae (one taxon), and Micrabaciidae (one taxon). The Zoantharia includes two families: Epizoanthidae (one species) and Parazoanthidae (three species).

The Octocorallia includes two orders (Malacalcyonacea and Scleralcyonacea) and is far more speciose than the Hexacorallia. The Malacalcyonacea includes five families: Alcyoniidae (six taxa), Clavulariidae (four taxa), Gorgoniidae (two taxa), Malacalcyonacea *incer-*

tae sedis (nine taxa), and Paramuriceidae (four taxa). The Scleralcyonacea includes five families: Chrysogorgiidae (seven taxa), Coralliidae (12 taxa), Keratoisididae (13 taxa), Primnoidae (27 taxa), and Sarcodictyonidae (two taxa). The Scleralcyonacea also includes the superfamily Pennatuloidea that is composed of nine families: Anthoptilidae (six taxa), Balticinidae (three taxa), Kophobelemnidae (one taxon), Pennatulidae (three taxa), Protoptilidae (one taxon), Stachyptilidae (one taxon), Umbellulidae (one taxon), Veretillidae (one taxon), and Virgulariidae (three taxa).

Corals in the class Hydrozoa are represented only by the order Anthoathecata with 23 taxa in the family Stylasteridae.

Note that not all taxa identified in this guide have been confirmed by examination of microscopic features and/or molecular analyses; those taxa are listed generically until additional taxonomic work can be completed (Table 1).

Twenty taxa listed in Table 1 have been identified to genus based on examination of microscopic features and/or molecular analyses but have not yet been described to species level. Twenty-two taxa in Table 1 have been confidently assigned to genus based on gross morphological features and ecology, and are now queued for sclerite examination, molecular analyses, and formal description if applicable. We have identified three taxa to genus based solely on the information available from videography and associated ecology. Finally, three taxa are listed as "cf.," meaning "confer or compare to." That is, specimens may be the species "compared to" but appear sufficiently different enough that closer examination is warranted. For example, we list "*Virgularia* cf. *bromleyi*" to mean the taxon is very similar to "*Virgularia bromleyi*" but should be more carefully compared to known material for verification as it may represent an unknown or undescribed taxon. Altogether, 45 taxa are listed in Table 1 for which museum specimens are available for future taxonomic study.

The state of taxonomy for Antipatharia is good with only four taxa (*Bathypathes* sp. A, *Bathypathes* sp. B, *Lillipathes* sp. A, and *Parantipathes* sp. A) in need of additional work, and the collection of *Dendrobathypathes* sp. known only from video records is a high priority. The taxonomy of all known Alaska Scleractinia is now complete with the description of *Flabellum* (*Flabellum*) *oclairi* sp. nov. included in this guide. The state of taxonomy for Zoantharia is poor, but promising leads using molecular genetics analyses are currently underway.

The state of the taxonomy for Octocorallia (excluding Pennatuloidea) is fair (65% of the 86 taxa have complete taxonomy) but varies greatly among families. The state of taxonomy is complete for Primnoidae and Gorgoniidae and nearly complete for Paramuriceidae, Clavulariidae, and Sarcodictyonidae (each family has only one taxon with incomplete taxonomy). Contrastingly, the state of the taxonomy for Chrysogorgiidae, Coralliidae, and Keratoisididae is poor, with the majority of taxa (85%) in need of additional work or collection. The taxonomy for the family Malacalcyonacea *incertae sedis* includes nine taxa in Alaska waters whose phylogentic positions are still unknown or uncertain (*incertae sedis*) above the genus level but is well established to species for eight of the nine taxa recently placed in the group by McFadden et al. (2022). The state of taxonomy for Pennatuloidea is fair to poor. About 50% of the listed taxa have incomplete taxonomy that may require higher-level taxonomic revision. Finally, the state of taxonomy for Stylasteridae is excellent.

Zoogeography of corals

Corals have been documented in all six regions of Alaska but the number of taxa and the representation of corals from the six major coral groups (antipatharians, scleractinians, zoantharians, octocorals, pennatuloideans, and stylasterids) varies greatly between regions. Three regions (eastern GOA, western GOA, and the Aleutian Islands) support corals from all major coral groups, while stylasterids have not been reported from the GOASP or the Bering Sea regions; and the Alaska Arctic region is represented only by a single species of octocoral. The Aleutian Islands region is the most species rich with 104 reported taxa, followed by the GOASP (57 taxa), the eastern GOA (44 taxa), the western GOA (31 taxa), the Bering Sea (21 taxa), and the Alaska Arctic (one taxon). A summary for each of the six regions of Alaska follows.

Forty-four coral taxa from the six major coral groups are reported from the eastern GOA region, including six antipatharians, four scleractinians, two zoantharians, 15 octocorals, nine pennatuloideans, and eight stylasterids (Appendix II). Eleven taxa from the region are found nowhere else in Alaska, and of those, the eight taxa with complete taxonomy are found or suspected to occur further south along the west coast of North America, indicating a strong taxonomic affinity with the coral fauna of that region (Boutillier et al., 2019).

Thirty-one coral taxa from the six major coral groups are reported from the western GOA region, including three antipatharians, three scleractinians, one zoantharian, 13 octocorals, seven pennatuloideans, and four stylasterids (Appendix II). Four taxa known from the region are found nowhere else in Alaska, and of those, the three taxa with complete taxonomy are found elsewhere in the North Pacific Ocean.

Fifty-seven coral taxa from five major coral groups are reported from the GOASP region, including 12 antipatharians, three scleractinians, one zoantharian, 37 octocorals, and four pennatuloideans (Appendix II). Stylasterids have not been reported from the seamounts region. Thirty-one (54%) of the taxa known from the region are found nowhere else in Alaska, indicating the seamounts likely have a high degree of endemism. Of the 31 taxa, only 10 have complete taxonomy, which is not surprising since the region has only recently been the subject of exploration and specimen collection. Seven of the 10 taxa with complete taxonomy appear to be endemic to Alaska seamounts; that number is likely to rise significantly as museum specimens are critically examined and additional collections are made.

A total of 104 coral taxa from the six major coral groups are reported from the Aleutian Islands region, including five antipatharians, six scleractinians, one zoantharian, 58 octocorals, 13 pennatuloideans, and 19 stylasterids (Appendix II). Sixty-two (59%) of the taxa known from the region are found nowhere else in Alaska, and of those, 50 taxa (81%) have complete taxonomy. Thirty-four of the 50 taxa (68%) with complete taxonomy appear to be endemic to the region, indicating that the archipelago has a high degree of endemism. Of the remaining 16 non-endemic taxa, 11 are known only from Russian and/or Japanese waters, indicating a strong taxonomic affinity with the coral fauna of the Northwest Pacific Ocean.

Only 21 coral taxa from five major coral groups are reported from the Bering Sea region, including two antipatharians, one scleractinian, one zoantharian, 11 octocorals, and six pennatuloideans (Appendix II). Stylasterids have not been reported from the Bering Sea. No species are endemic to the region as all known taxa occur in other regions of Alaska.

Only a single species of octocoral, the sea strawberry (*Gersemia rubiformis*) (Ehrenberg, 1834), is known from the Alaska Arctic region where it is abundant in some areas (Table 1). Although this region of Alaska has been the focus of new research programs during the past decade, it is still by far the least explored region particularly with regard to coral habitat. There are several museum specimens of indeterminate or questionable taxonomy that need attention so a few taxa may be added in the future to the inventory, but the region is clearly depauperate in corals.

Collection and preservation of specimens

In each chapter summary, and in some species profiles, we identify specific taxa as high priorities for future collection. The highest priorities for collection are taxa with incomplete taxonomy, taxa identified solely on photographic evidence (of which there are three), and any specimens that are unfamiliar and suspected of being different from the 161 taxa presented in this guide. This guide can be used to facilitate collection of the first two priority categories by providing the known locations of those taxa. Additionally, we recommend for collection those specimens that appear to be of known taxa but are evidently a geographic or bathymetric range extension for that species. Other high-priority collections include those taxa for which museum collections are quantitatively or qualitatively inadequate to provide comprehensive species descriptions and to support taxonomy and systematics work using molecular genetics. For example, some taxa are known only from one or few specimens; others from incomplete, fragmented specimens; and still others from poorly or inappropriately preserved specimens.

The collection protocols outlined by Etnoyer et al. (2006) for deep-water corals are suitable for the collection of all Alaska corals. However, through the process of constructing this guide, we have noted protocols that have been performed inadequately or inconsistently (and consequently have been problematic) so we provide the preferred protocols again here with slight modification.

Shortly after collection, specimens should be photographed on a solid, clean, and dry background with (and without) an appropriate scale and specimen identifier label (equivalent to “field number” in the USNM database). This label will ultimately link the specimen with metadata that importantly must include the following station data: 1) field number, 2) date of collection, 3) station number (station, haul, set or dive number, etc.), 4) vessel name, 5) name of collector, 6) collection method, 7) latitude and longitude, and 8) depth.

When collecting specimens, imagery (still photos and/or video) should include the subject and surrounding habitat from multiple perspectives and with various lighting options. Imagery of the subject should also include the nearby substrate, if possible, and the projection of scaling lasers on a flat surface (preferably on the subject) so the area of view and size of objects are measured accurately. Broad-scale imagery can provide important habitat information regarding patch density and associated fauna. Close-up imagery can provide valuable information on the presence of microfauna that may not be retained with collected specimens and diagnostic features of the specimen, including polyps in both extended and retracted states. Documentation of polyp retraction can easily be achieved by gently agitating the colony with the submersible’s manipulator.

Sampling of a branch or small branch complex is generally adequate for taxonomic identification, but if the specimen is suspected of being an unknown or high-priority taxon (i.e., one that might be designated as a type), then the whole specimen including the holdfast should be collected if possible. If the whole specimen is difficult to detach from the substrate, then consider collecting the substrate (cobble or siltstone) with the whole specimen attached. Save the substrate appropriately; a geologist may be able to provide important geological habitat information as a bonus. If specimens are small and plentiful, consider collecting several as species descriptions based on more than one specimen are most valuable. When sampling bamboo corals (family Keratoisididae), attempt to collect branch complexes consisting of both nodes and internodes since branching pattern is a valuable diagnostic characteristic for some taxa.

Great care should be taken to ensure that the actual process of specimen collection and securing specimens in payload containers is carefully video-documented. Because multiple specimens are often stowed in the same containers, scientists often need to review imagery of the collections to accurately sort and label specimens, ensuring that they are linked to the proper station data. Specimens are occasionally not secured and properly stowed, only to be lost before arriving on deck. At a minimum, the proper and secure storage of each specimen should be documented with video imagery.

All coral specimens may be frozen (preferably at temperatures below –10°C) but ideally stored in an 80–90% ethanol solution. Specimens to be used for histological purposes may be fixed in a buffered 5% formaldehyde solution for 24 hours prior to storage in ethanol solution. Specimens to be used for molecular genetic analyses should be frozen (preferably to –10°C or colder) or preserved by other methods (e.g., smeared on Whatman FTA cards [GE Healthcare Lifesciences, Chicago, IL] or placed in RNALater [Ambion, Inc., Austin, TX]) for restriction-site associated DNA sequencing. For museum archiving, specimens should be stored in an 80–90% ethanol solution. Very large specimens may be dried but a fragment of the specimen should be stored in ethanol solution.

Researchers responsible for the collected specimens should ensure that the properly preserved specimens are transferred as soon as practical to the museum where they will be permanently archived. Each specimen should be accompanied with all appropriate metadata and photographs. If the specimen has been partitioned, then the record should indicate the repository and custodian of the sample, especially if it is the parent specimen. Finally, the principal researcher or assistant should verify that the specimen records entered into archived databases are accurate and complete. Approximately 5–10% of the thousands of data records we examined while constructing this guide contained inaccurate or incomplete data.

CHAPTER 2

Class Anthozoa
Subclass Hexacorallia
Order Antipatharia

Corals in the order Antipatharia are referred to as black or thorny corals, principally due to the color of their hard proteinaceous axial skeleton and the presence of thorns on the skeletal surface. Skeletons are covered with a thin, fragile coenenchyme bearing small non-retractable polyps with six non-retractile tentacles.

Currently there are seven families in the order. Families are differentiated based on the internal and external morphology of the polyps (Fig. 2-1), and on the morphology of the spines (Fig. 2-2). Genera are recognized primarily by the morphology of the corallum, and species are separated by differences in the size of the polyps and spines and minor alterations in the growth pattern of the corallum (i.e., size and density of primary pinnules; and number, size, and arrangement of subpinnules, if present; Fig. 2-3).

The current state of taxonomy for the group is good, but is likely to undergo revision as more DNA data become available to help define the limits of species variability. For some genera, such as *Bathypathes*, the DNA results so far have revealed the possible existence of more species than that suggested by morphology alone.

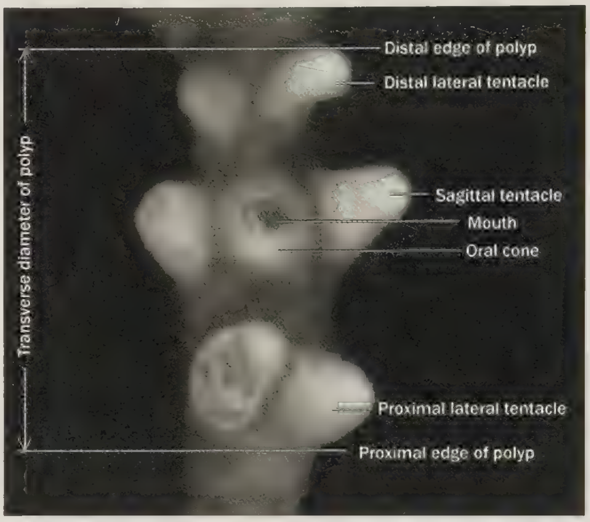

Distal edge of polyp
Distal lateral tentacle
Sagittal tentacle
Mouth
Oral cone
Proximal lateral tentacle
Proximal edge of polyp
Transverse diameter of polyp

Figure 2-1

Characteristic features of polyps in the order Antipatharia.

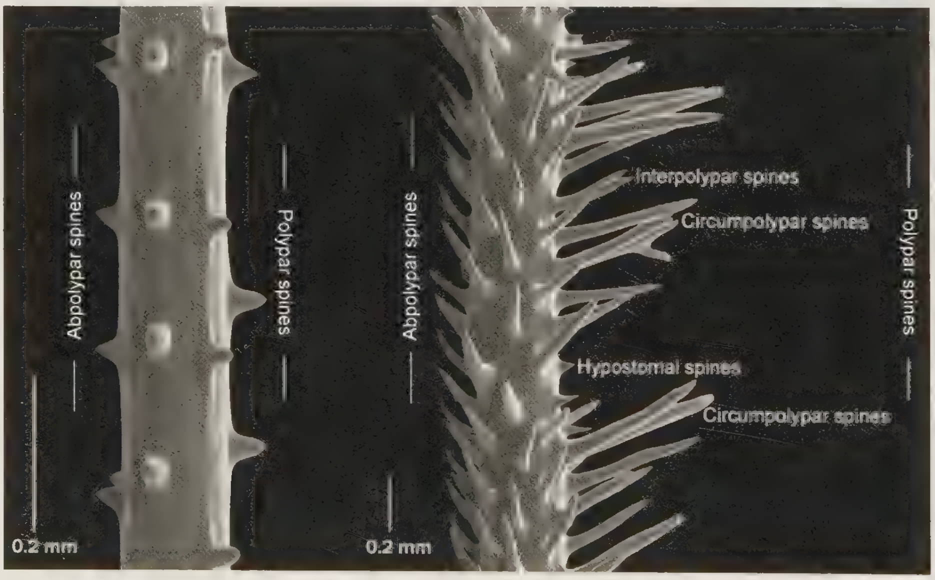

Abpolypar spines
Polypar spines
Abpolypar spines
Interpolypar spines
Circumpolypar spines
Polypar spines
Hypostomal spines
Circumpolypar spines
0.2 mm
0.2 mm

Figure 2-2

Characteristic morphology of skeletal spines in corals in the order Antipatharia. Most species found in Alaska waters are more similar to the illustration on the left.

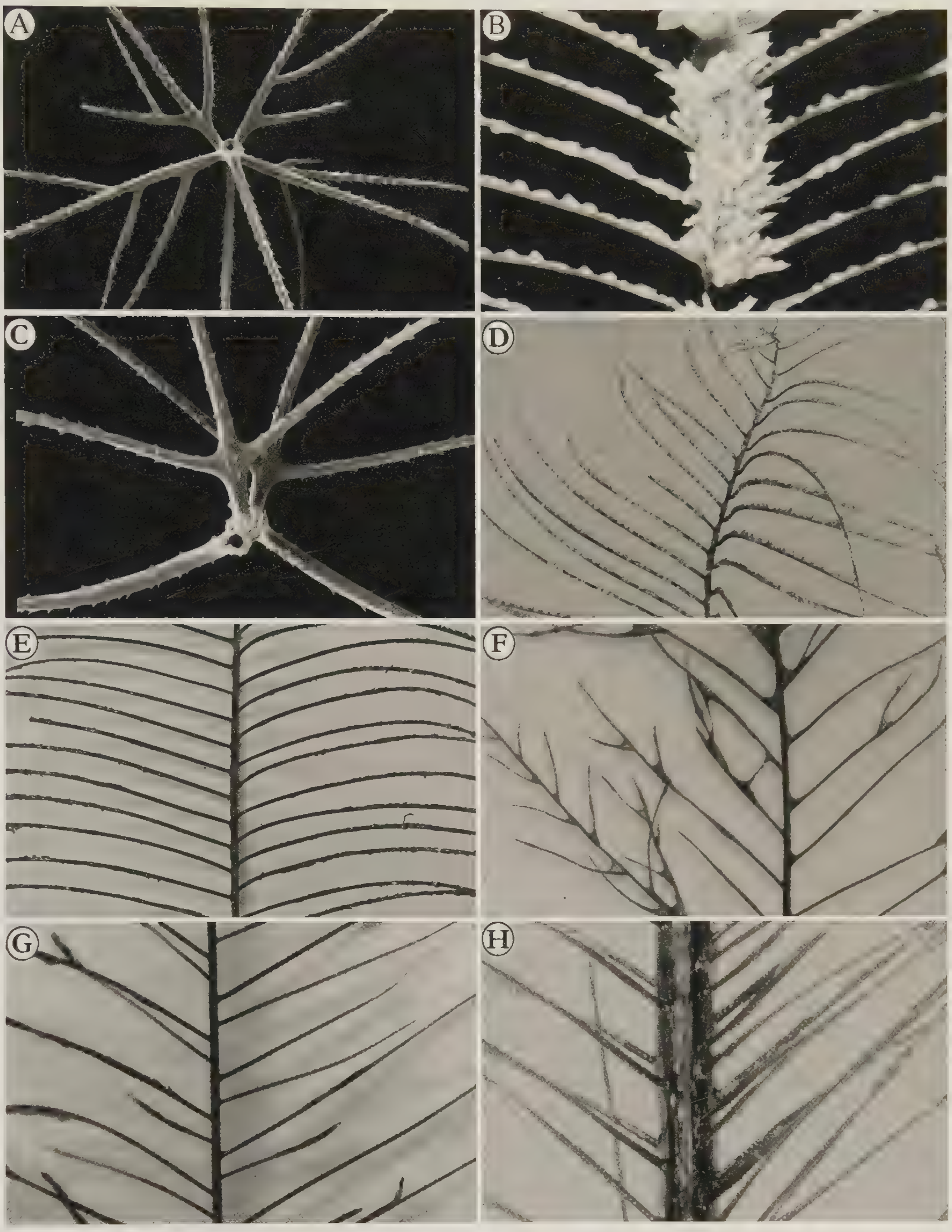


Figure 2-3

Illustrations of pinnulation patterns typical of genera in the order Antipatharia found in Alaska waters. (A) *Chrysopathes:* view from a distal branch end showing a single set of pinnules, one from each of six axial rows, with two simple posterior pinnules, two lateral pinnules with secondary pinnules, and two anterior pinnules with secondary and tertiary pinnules. (B) *Heteropathes*: a lateral view of the front of the corallum showing two rows of simple bilateral pinnules and numerous small anterior pinnules with subpinnules. The pinnules are obscured by soft tissue. (C) *Trissopathes*: view from a distal branch end showing a single set of pinnules, one from each of four axial rows, with two simple lateral pinnules and two anterior pinnules, each with two subopposite secondary pinnules. (D) *Alternatipathes*: a lateral view of the front of the corallum with simple alternating pinnules in two lateral rows. (E) *Bathypathes*: an oblique lateral view of the front of the corallum with simple pinnules arranged bilaterally and suboppositely in two rows. (F) *Dendrobathypathes*: a lateral view of the front of the corallum. Primary pinnules are bilateral and alternating in two rows. A few primary pinnules have a single secondary pinnule. (G) *Lillipathes*: a lateral view of the front of the corallum. The pinnules are simple, in four rows, and in bilateral alternating groups of two each. (H) *Parantipathes*: a lateral view of the front of the corallum. The pinnules are simple, in up to eight axial rows, and in irregular but generally bilateral alternating groups of three or four each.

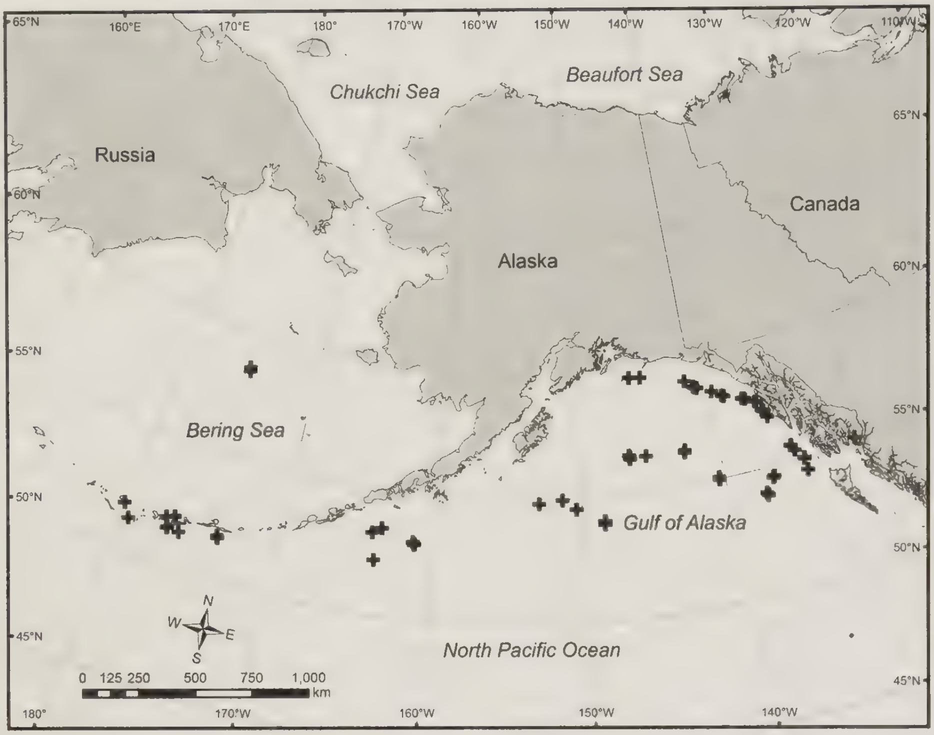


Figure 2-4

A map of the North Pacific Ocean showing the distribution of corals in the order Antipatharia (+) in Alaska waters.

Here we list eight previously known species and five new species that have recently been described due in large part to an effort to make this guide as complete and comprehensive as possible. Additionally we list five taxa (*Bathypathes* sp. A, *Bathypathes* sp. B, *Dendrobathypathes* sp., *Lillipathes* sp. A, and *Parantipathes* sp. A) that have not yet been formally described; although these forms appear to be morphologically unique, additional specimens and DNA analysis are needed to determine if they represent different species or are only variants of known species.

The antipatharian fauna of the Northeast Pacific Ocean has only been extensively described in the past few decades (Opresko, 2003, 2005; Molodtsova and Opresko, 2017; Opresko and Molodtsova, 2021). Based on those studies and more recently collected material, 18 taxa from two families (Cladopathidae and Schizopathidae) are currently known to occur in Alaska waters. They are found in all major regions except the Arctic, and *Parantipathes pluma* Opresko and Molodtsova, 2021, found as far north as Zhemchug Canyon in the eastern Bering Sea, is one of the northernmost corals in the North Pacific Ocean.

Antipatharians are widespread in Alaska waters, occurring in all regions except the Arctic (Fig. 2-4), and they are particularly abundant on seamounts in the Gulf of Alaska Seamount Province. They are deep-water fauna in Alaska and occur at depths between 329 and 4950 m. They typically grow on firm rock but are often found on siltstone, particularly on the continental slope in the eastern Gulf of Alaska. Some species can grow to more than a meter high and wide and these larger colonies often harbor swarms of euphausiids and other fauna. Colonies of most species are found either singly or in low-density fields. They are a fairly common bycatch item in longline fisheries and stock assessment surveys and, given their very strong axes, are most typically dislodged whole with the holdfast.

Family Cladopathidae

1. *Chrysopathes formosa* Opresko, 2003

Description (Adapted from Opresko, 2003) Colonies (i.e., coralla) are branched primarily in a single plane with five or more orders of branches. Colonies are up to 53 cm in height, at least 32 cm in width, and 4 mm in basal stem diameter. The stem and branches are pinnulate. Secondary pinnules are present on some primaries; tertiary pinnules are absent. Over most of the corallum, primary pinnules are arranged in six rows and in alternating biserial groups of three pinnules; each group consists of one anterolateral, one lateral (or posterolateral), and one posterior pinnule. Near the distal end of the branches there can be only four rows of primary pinnules. Lateral primary pinnules are up to 2 cm in length, simple or occasionally with a single secondary pinnule; anterolateral primary pinnules are generally less than 1.5 cm in length, simple or with one or two secondary pinnules arising near the base. Posterior primary pinnules are usually not more than 0.5 cm in length and without subpinnules. Primary pinnules are spaced 3–4 mm apart in each row, with 15–18 pinnules/cm.

Pinnular spines are triangular to conical in lateral view, acute, directed out almost horizontally on the lower parts of the pinnules, but becoming more inclined upward on the distal sections. Spines are generally less than 0.12 mm in height on the primary pinnules, slightly taller on the secondaries, and shorter on the main branch and larger branches.

Polyps have six primary mesenteries and no secondary mesenteries. Polyps are elongated transversely in the direction of the axis; 1.8–3.0 mm in transverse diameter (as measured from the outer edge of the proximal lateral tentacles to the distal edge of the distal lateral tentacles); and are arranged in a single row on one side of the pinnules and subpinnules.

Holdfasts are quite large but thin, asymmetrical, and fairly easily detached. Color of flesh in life is creamy white; gold to pale yellow when frozen or dried.

Remarks This species is very similar to *Chrysopathes speciosa* Opresko, 2003 with which it co-occurs, but differs in having fewer secondary pinnules. Secondaries are rare on the lateral primary pinnules and there are no tertiary pinnules. Spines are not as strongly inclined distally, the primary pinnules are spaced further apart, and the polyps are slightly smaller than those in *C. speciosa*.

This species often harbors ophiuroid and hippolytid shrimp associates.

Distribution Locally common. In Alaska – eastern Gulf of Alaska continental slope (Fig. 2-5). Elsewhere – known only from a few locations off the west coast of the Americas (Jasper Seamount off Baja California, Mexico to Ecuador).

Habitat In Alaska – grows predominantly on siltstone but occasionally on bedrock, cobbles, and pebbles in deeper areas of the continental slope at depths between 619 and 756 m and often in low density patches with the congener *C. speciosa*. Elsewhere – depths between 700 and 895 m.

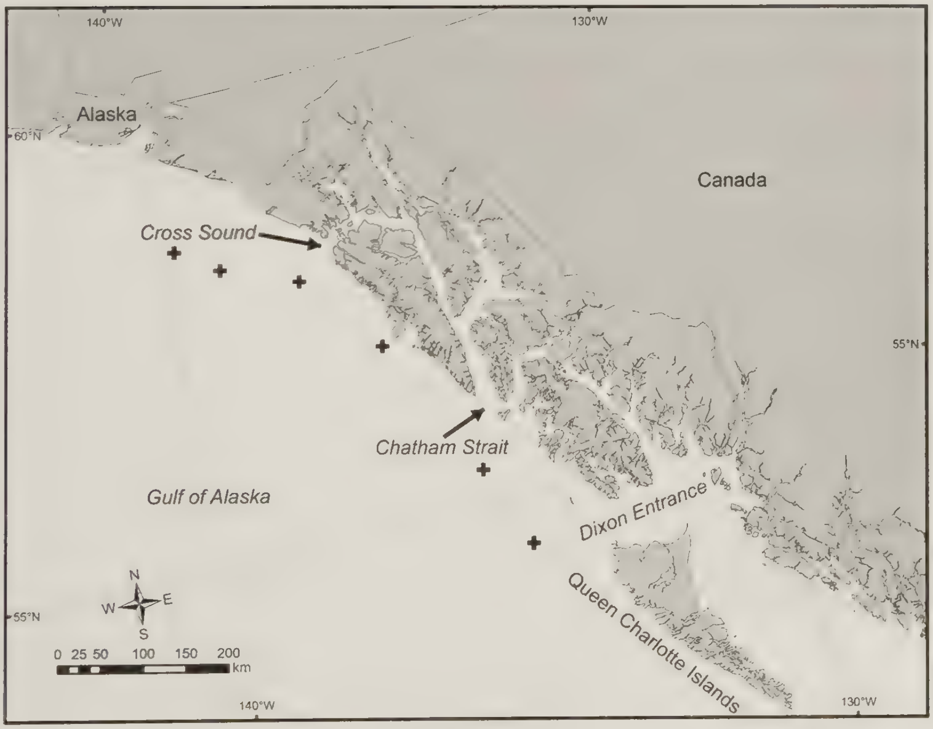
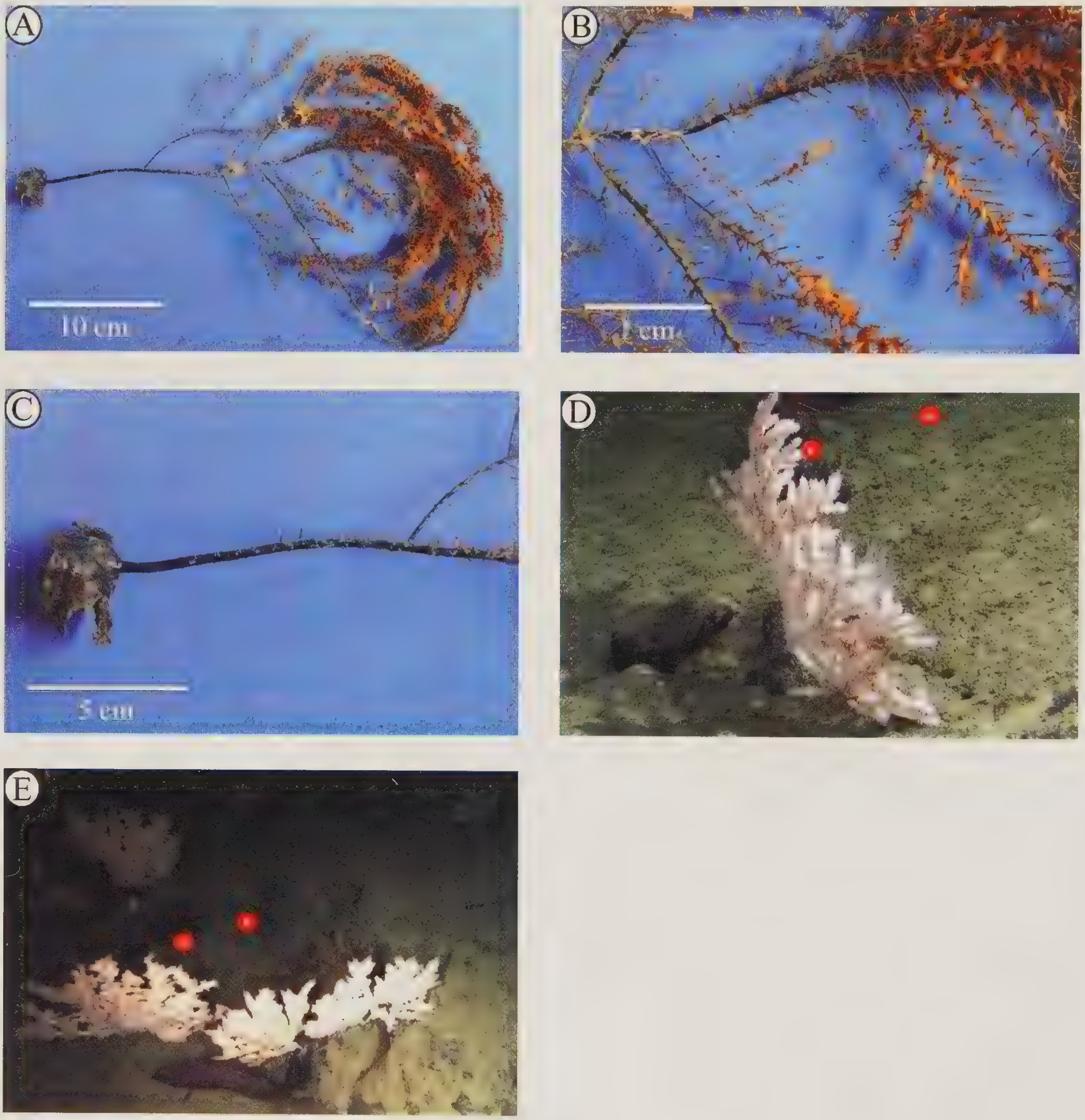


Figure 2-5

A map of the eastern Gulf of Alaska showing the distribution of *Chrysopathes formosa* (+) in the Alaska waters.

Photos A) A preserved (frozen then dried) whole *C. formosa* colony (USNM 1484090) collected in the eastern Gulf of Alaska at a depth of 756 m. B) A close-up view of the same specimen in photo A. C) A close-up view of the holdfast of the same specimen in photo A. D) A *C. formosa* colony (USNM 1288460) in the eastern Gulf of Alaska at a depth of 619 m. The distance between the red laser marks is 10 cm. E) A patch of *Chrysopathes* spp. on a bedrock ledge in the eastern Gulf of Alaska at a depth of 715 m. A giant grenadier (*Albatrossia pectoralis*) takes cover in the patch of corals. The distance between the red laser marks is 20 cm.



2. *Chrysopathes speciosa* Opresko, 2003

Description (Adapted from Opresko, 2003) Colonies (i.e., coralla) are branched primarily in a single plane but sometimes bushy. Colonies are to at least 55 cm in height and at least 45 cm in width, and up to 6 mm in basal stem diameter. Stem and branches are pinnulate. Primary pinnules are arranged equidistantly around the axis in four rows near the tips of branches, increasing to six rows on lower sections of branchlets, and in alternating bilateral groups of two or three pinnules, one from each row; 18–27 pinnules/cm for all rows. Primary pinnules are usually not more than about 1 cm in length, subequal or with laterals slightly longer than anterior and posterior ones. Primary pinnules near tips of branches are mostly simple or with one secondary pinnule on anterior primaries only; becoming increasingly subpinnulate on the lower parts of the branches, with one or more secondary pinnules occurring on anterior and lateral primary pinnules, but only infrequently on posterior primary pinnules. There are up to four secondary pinnules on some primary pinnules. Arrangement and spacing of secondary pinnules are highly variable, either alternate, uniserial, subopposite, or irregular. Secondary pinnules are inclined distally relative to the direction of the primary pinnule, and projecting laterally or somewhat distally or basally. Tertiary pinnules are present on some secondaries.

Spines on pinnules are simple, smooth, conical, acute, subequal, and are usually directed or curved distally, especially towards the distal end of the pinnules. Spines are generally less than 0.12 mm in height (maximum 0.18 mm in height) on the primary pinnules and slightly shorter on the secondaries. Spines on branches and the stem are ≤0.05 mm.

Polyps have six primary mesenteries and no secondary mesenteries. Polyps are elongated transversely in the direction of the axis; transverse diameter is 2.0–3.3 mm (including tentacles) and arranged in a single row on one side of the pinnules and subpinnules.

Holdfasts are quite large but thin, asymmetrical, and fairly easily detached. Color of flesh in life is creamy white; gold to pale yellow in frozen or dried specimens.

Remarks This species is very similar to *Chrysopathes formosa* with which it co-occurs but differs in having more numerous subpinnules on the anterolateral primaries (Fig. 2-3A). Secondaries are not uncommon on the lateral primary pinnules and tertiary pinnules are present. Spines are more typically inclined distally, the primary pinnules are spaced closer together, and the polyps are slightly larger in transverse diameter than in *C. formosa*. Colonies often host ophiuroid and hippolytid shrimp associates.

Distribution Locally common. In Alaska – eastern Gulf of Alaska continental slope (Fig. 2-6). Elsewhere – known only from a few locations off the west coast of North America from northern British Columbia to California.

Habitat In Alaska – grows predominantly on siltstone but occasionally on bedrock, cobbles, and pebbles in deeper areas on the continental slope at depths

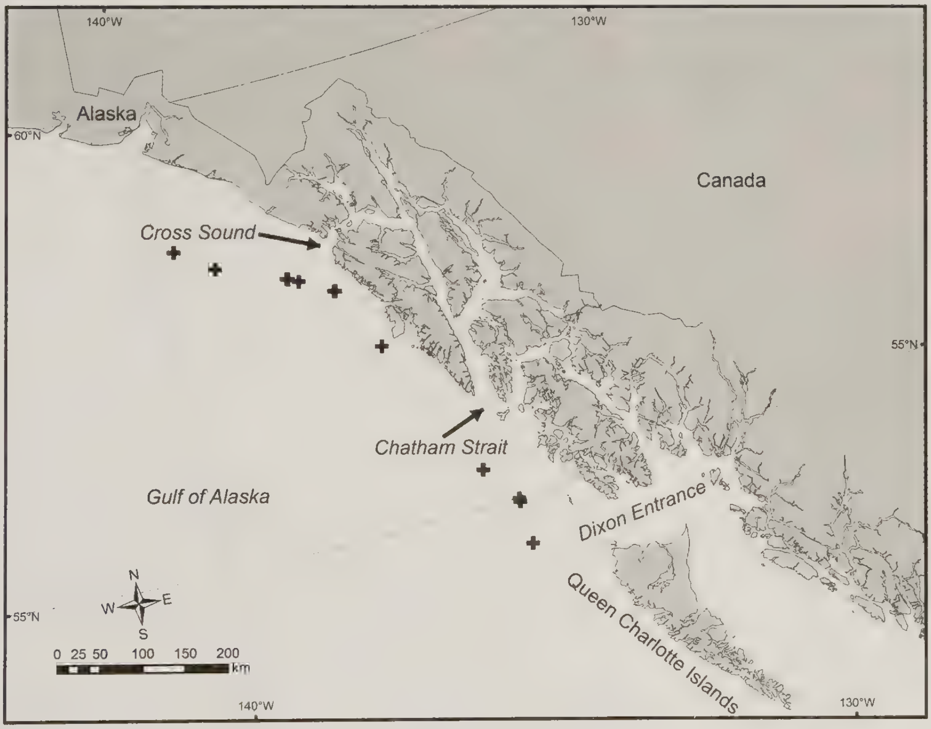
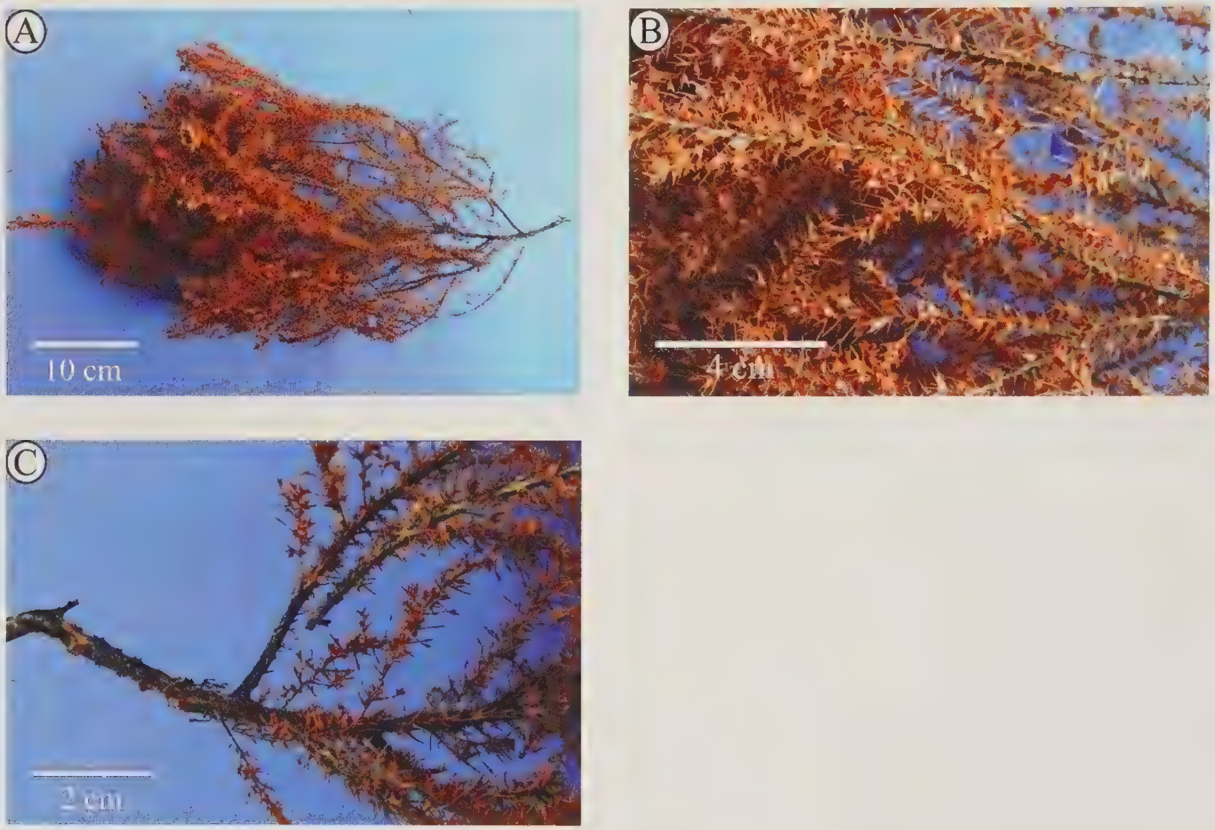


Figure 2-6

A map of the eastern Gulf of Alaska showing the distribution of *Chrysopathes speciosa* (+) in Alaska waters.

between 648 and 914 m and often in low-density patches with the congener *C. formosa*. Elsewhere – depths between 732 and 1168 m.

Photos A) A preserved (frozen then dried) whole *C. speciosa* specimen (USNM 1014116) collected in the eastern Gulf of Alaska at a depth of 812 m. B) A close-up view of the same specimen in photo A. C) A close-up view of the stalk of the same specimen in photo A.



3. *Heteropathes pacifica* (Opresko, 2005)

Description (Adapted from Opresko, 2005) The corallum is monopodial with the stem extending to the top of the colony, and pinnulate. Colonies are to at least 32 cm in height and at least 19 cm in width. Pinnules are arranged along the stem in two lateral rows of long pinnules, one on each side, and also in one to two irregular anterior rows of very short pinnules (Fig. 2-3B). Lateral pinnules are simple (without subpinnules), ≥5.5 cm in length, arranged alternately, and inclined and curved distally. Adjacent lateral pinnules are on the same side of the axis about 5 mm apart, resulting in 3 pinnules/cm. Adjacent lateral pinnules are on opposite sides of the stem 2.0–2.5 mm apart. Anterior primary pinnules are short, <1 cm, and subpinnulate with 1–4 secondary pinnules. Anterior pinnules are spaced 1.5–2.0 mm apart irregularly, with 8–10 occurring along 1 cm of the axis. Secondary pinnules are equal in length to the anterior primary pinnules. There are up to four secondary pinnules on one anterior primary; the two lowermost ones are almost subopposite (about 0.2 mm apart) on lateral sides of the primary and at right angles to the direction of stem. There are two distal secondaries (about 0.5 mm apart) on the upper and lower sides of the primary. Secondary pinnules are curved distally to become nearly parallel to the anterior primary from which they originate. Secondary pinnules are sometimes subpinnulate, with tertiary pinnules occurring on the upper and lower sides. Anterior primary pinnules and subpinnules extend out nearly perpendicular to the plane containing the stem and lateral pinnules.

Spines on the lateral pinnules are small (0.03–0.06 mm in height from the center of the base to the tip), triangular, compressed, and nearly at right angles to the axis. Four or five rows are visible in one lateral view. Spacing of spines is highly variable, but is typically 0.32–0.37 mm, resulting in about 4 spines/mm. Spines on the anterior primary pinnules are similar in size and shape to those on the lateral primary pinnules. Spines on distal portions of some subpinnules are slightly larger (up to 0.07 mm), more acute, and more distally directed than those on primary pinnules.

Polyps have six primary mesenteries and no secondary mesenteries. Polyps on lateral pinnules are mostly 4.5–5.2 mm (range 3.9–5.5 mm) in transverse diameter (from the distal edge of distal lateral tentacles to the proximal edge of the proximal lateral tentacles); arranged in one row, with 2–3 polyps/cm. Polyps on anterior pinnules and subpinnules are highly modified, elongate and tear-drop in shape, with the proximal section usually wider than the distal portion. The mouth is offset towards the distal end of the polyp. Tentacles are absent or reduced to just one pair.

The holdfast is relatively large but thin, asymmetrical, and not particularly strong. Color of the coenenchyme in life is orange (a darker orange than *Alternatipathes mirabilis* Opresko and Molodtsova, 2021 and *Bathypathes ptiloides* Opresko and Molodtsova, 2021 with which it co-occurs) and lighter orange in ethanol.

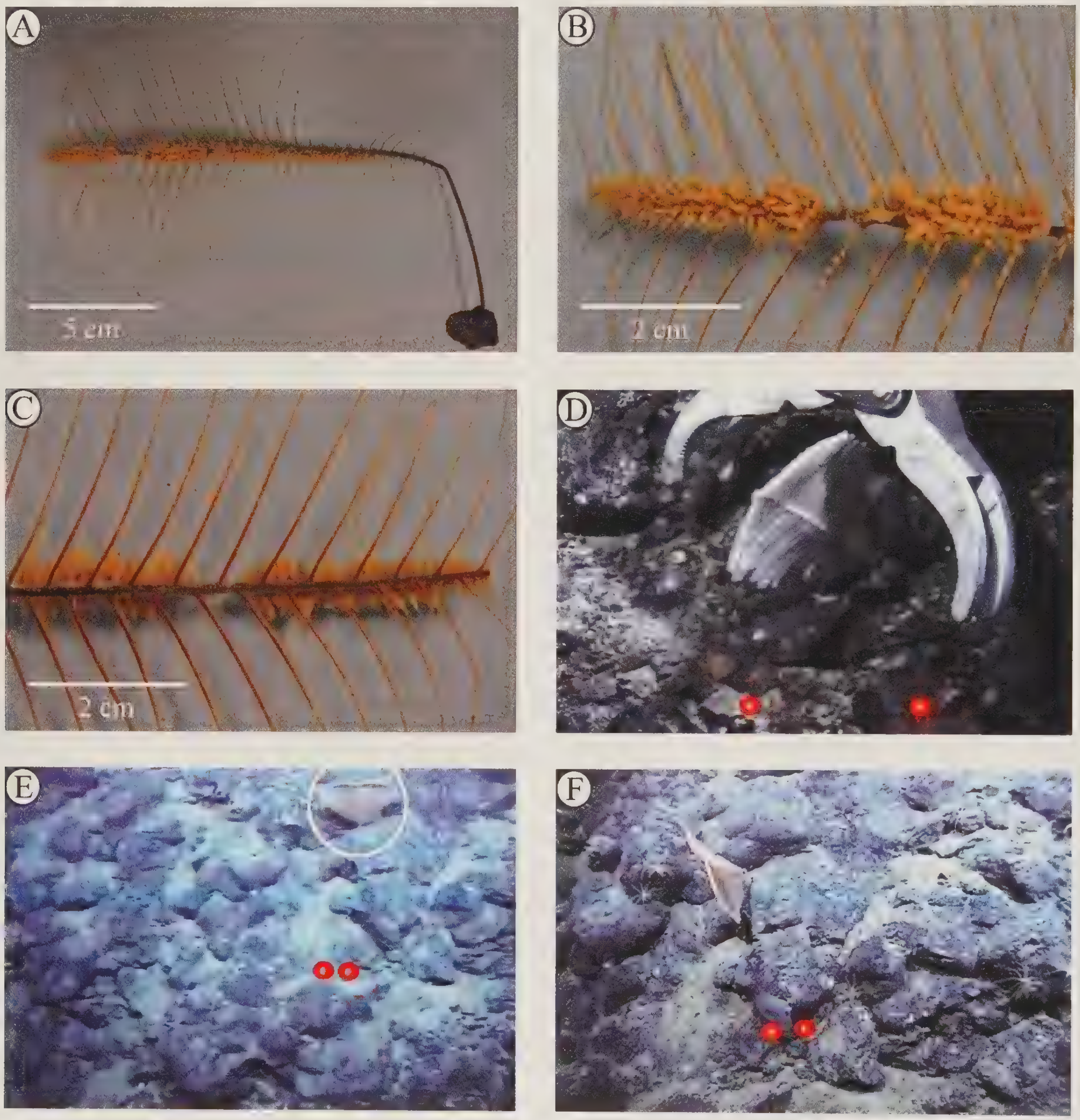
Remarks This species was originally described as *Heliopathes pacifica* Opresko, 2005.

Distribution Rare. In Alaska – known only from Derickson Seamount in the western Gulf of Alaska (Fig. 2-7). Elsewhere – similar morphotypes (*Heteropathes* cf. *pacifica*) have been recorded from Gorda Ridge off Oregon (USNM 1234550) and from New Zealand (USNM 1527070).

Habitat In Alaska – grows on siltstone and fragmented basalt at depths between 3563 and 4511 m but observed on video footage to depths of 4663 m (senior author, personal observ.). Elsewhere – morphotypes found at depths between 1621 and 3030 m.

Photos A) The preserved (in ethanol) *H. pacifica* holotype (USNM 1070758; whole colony) collected on Derickson Seamount in the western Gulf of Alaska at a depth of 3563 m. B) A close-up dorsal view of the same specimen in photo A. C) A close-up ventral view of the same specimen in photo A. D) The same colony in photo A at the time of collection in the western Gulf of Alaska. E) A *H. pacifica* colony (indicated by the white circle) observed on Derickson Seamount at a depth of 4663 m. F) An alternate view of the same colony in photo E. The distance between the red laser marks in photos D–F is 10 cm.

3. *Heteropathes pacifica* (Opresko, 2005) (continued)


A
5 cm
B
2 cm
C
2 cm
D
E
F

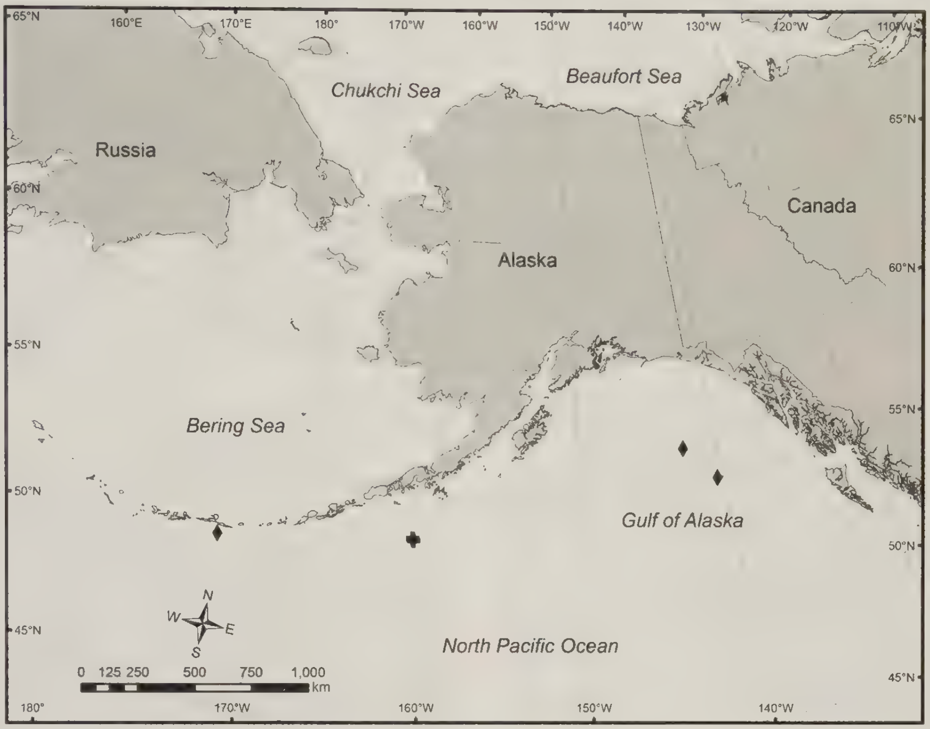

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
60°N
55°N
50°N
45°N
N
W
E
S
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W

Figure 2-7

A map of the North Pacific Ocean showing the distribution of *Heteropathes pacifica* (+) and *Trissopathes pseudotristicha* (◆) in Alaska waters.

4. *Trissopathes pseudotristicha* Opresko, 2003

Description (Adapted from Opresko, 2003) Coralla are branched in a single plane to the fourth order or more. Colonies are to at least 34 cm in height and at least 40 cm in width. The stem and branches are pinnulate and subpinnulate. Primary pinnules are arranged in four rows: two anterior (or anterolateral) rows of simple pinnules and two posterolateral rows of subpinnulate primary pinnules (Fig. 2-3C). Primary pinnules are also arranged alternately in bilateral groups containing one anterior and one posterolateral pinnule. Posterolateral primary pinnules are usually simple, mostly 1–2 cm in length (up to 2.6 cm), and directed distally. Anterior primary pinnules are 0.5–1.0 cm in length, directed nearly at right angles to the direction of the branch, and usually with a single subopposite pair of secondary pinnules occurring near the base of the primary pinnule (Fig. 2-3C). Secondary pinnules are only rarely found on posterolateral pinnules. Secondary pinnules are 0.5–1.5 cm in length. Secondary pinnules are not present on some anterior primaries, particularly those near the branch tips. Tertiary pinnules are usually absent. On thick branches the primary pinnules may have the appearance of being in more than four rows since the sclerenchyme of the branch overgrows the base of some secondary pinnules.

Spines on pinnules are simple, smooth, conical, and acute; 0.05–0.13 mm in height (from the center of the base to the apex), and often inclined distally, especially near the distal ends of primary pinnules and on secondary pinnules, in which case the abaxial edge is often two to three times longer than the adaxial edge. The largest spines are found on the distal half of secondary pinnules. Spines are arranged in axial rows with three or four rows visible in lateral view (excluding rows in which the spines are only partially visible). The distance between adjacent spines in each row is variable, ranging from 0.25 to about 0.4 mm; on average there are about 4 spines/mm in each row.

Polyps have six primary mesenteries and no secondary mesenteries. Polyps are 2–4 mm in transverse diameter, arranged uniserially on the upper or lateral sides of the pinnules and subpinnules, with 3–4 polyps/cm.

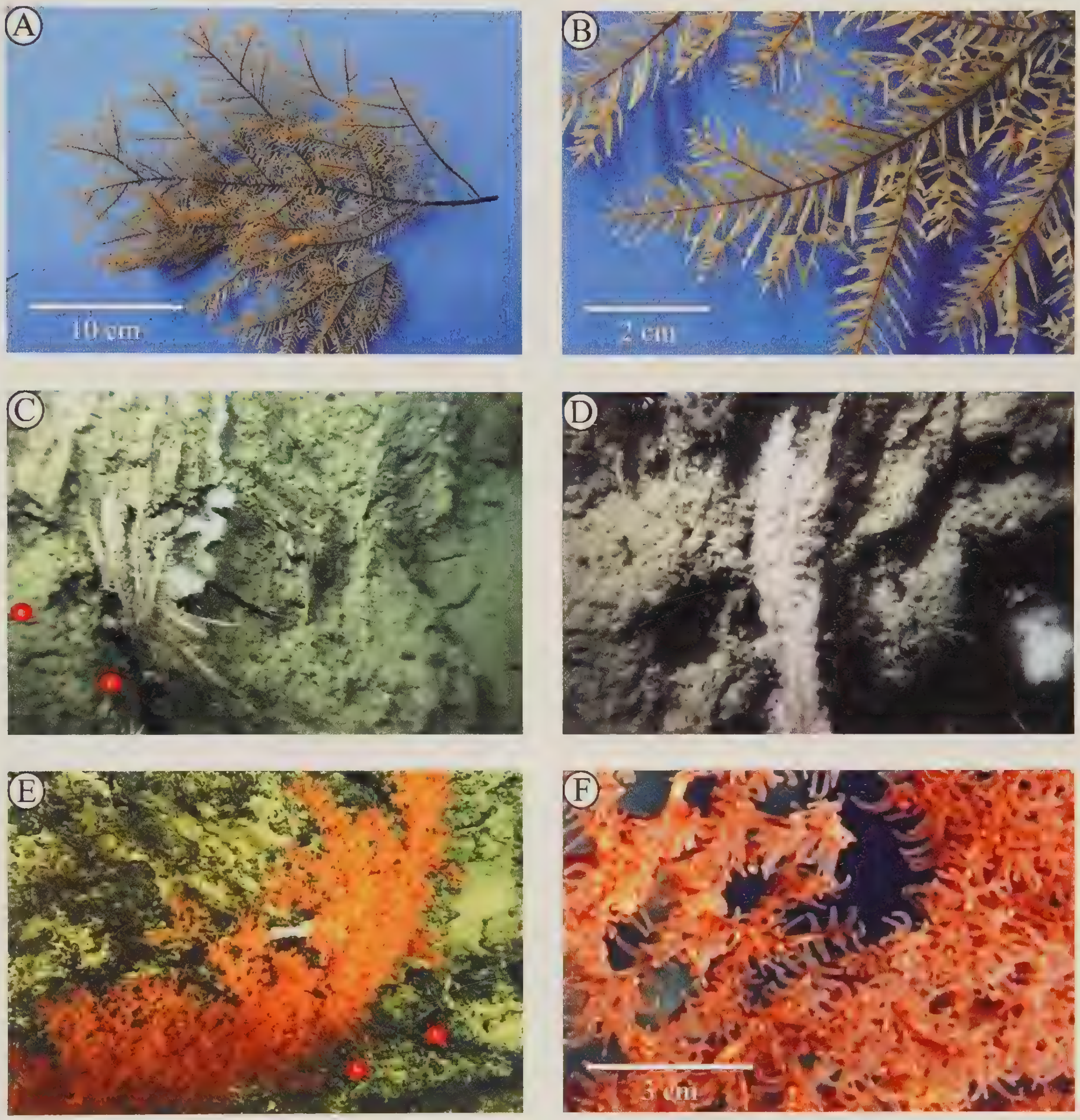
The color of the coenenchyme in life is bright to rusty orange and creamy white in ethanol.

Remarks This species is very similar to *Trissopathes tetracrada* Opresko, 2003 but with a greater number of secondary pinnules. *Trissopathes tetracrada* is known primarily from the Southwest Pacific (near New Zealand, Tasmania, and south of Australia), with a single record from the North Atlantic (Cape Verde Islands).

Distribution Uncommon. In Alaska – Gulf of Alaska Seamount Province (Welker and Pratt Seamounts) and the central Aleutian Islands (Fig. 2-7). Elsewhere – wide ranging; known from a few locations off the west coast of North America south to Fieberling Guyot (west of the Channel Islands) and the Hawaiian Islands including Necker Ridge.

Habitat In Alaska – grows on bedrock and fractured bedrock including basalt in small patches (up to 10 individuals together) at depths between 2635–2828 m but video observations (Stone, 2014) indicate the species ranges to as shallow as 2306 m. Elsewhere – eurybathic, depths between 227–2730 m.

Photos A) A large portion of a preserved (in ethanol) *T. pseudotristicha* colony (USNM 1070975) collected northeast of Oahu Island, Hawaii, at a depth of 396 m. B) A close-up view of the same specimen in photo A. C) A *T. pseudotristicha* colony collected on siltstone in the central Aleutian Islands at a depth of 2829 m. The distance between the red laser marks is 10 cm. D) A close-up view of the same colony in photo C. E) A cluster of *T. pseudotristicha* colonies on a rocky ridge in Kailua Bay, Hawaii, at a depth of 432 m. The holotype (USNM 98848) is the colony on the right. The distance between the red laser marks is about 10 cm. F) A close-up view of the holotype immediately before collection. Photos E and F are courtesy of S. France, L. Mullineaux, and the Hawaii Undersea Research Laboratory.


A
10 cm
B
2 cm
C
D
E
F
3 cm

Family Schizopathidae

5. *Alternatipathes mirabilis* Opresko and Molodtsova, 2021

Description (Adapted from Opresko and Molodtsova, 2021) Colonies are monopodial (with the stem reaching to the top of the corallum), unbranched, and pinnulate. Colonies are to at least 50 cm in height and at least 20 cm in width. The lower unpinnulated stalk can be considerably longer than the upper, strongly triangular-shaped, pinnulated section. The pinnulated section of the holotype is quite flat and extends horizontally in the water column in situ (see photos E and F). Pinnules are simple (without subpinnules), arranged alternately in two lateral rows (Fig. 2-3D), and generally decreasing in length from the lower part of the pinnulated section of the stem to the apex. Lowermost pinnules are >15 cm in length in large colonies. Pinnular density is 11–12 pinnules/3 cm.

The spines on pinnules are smooth, triangular in profile, moderately acute, laterally compressed, and mostly 0.04–0.05 mm in height on the polypar side of the axis. Polyps have six primary mesenteries and four secondary mesenteries, are 5–7 mm in transverse diameter, with 4–5 polyps/3 cm.

The holdfast is small, inconspicuous, typically covered with coenenchyme, and relatively easy to detach. The color of the coenenchyme in life and in ethanol is very light orange.

Remarks This species is similar to *Alternatipathes alternata* (Brook, 1889), but usually has a longer unpinnulated stalk, longer pinnules, a wider distal angle of the pinnules, and larger polyps.

This species is superficially quite similar to *Bathypathes ptiloides* with which it co-occurs but the pinnulated section of the colony is relatively smaller and more obviously triangular-shaped.

Distribution Rare. In Alaska – known from a single specimen (USNM 1070972) collected from Derickson Seamount in the western Gulf of Alaska and several video observations made nearby (Fig. 2-8). Elsewhere – not reported, but similar specimens identified only to genus have been collected off Washington (2453 m depth), California (west of the Channel Islands at 4100 m depth), Taney Seamount (3054 m depth), Gorda Ridge (2820 m depth), and near Hawaii (2638 m depth).

Habitat Always occurs singly, attached to basalt and fragmented basalt at depths between 4600 and 4685 m.

Photos A) The preserved (in ethanol) *A. mirabilis* holotype (USNM 1070972; whole colony) collected on Derickson Seamount at a depth of 4685 m. B) A close-up view of the branching pattern of the same specimen in photo A. C) A close-up view of the polyps on the same specimen in photo A. D) A photo of the collection of the holotype in situ. E) A suspected *A. mirabilis* colony observed on Derickson Seamount at a depth of 4680 m. F) A close-up view of the same colony in photo E. The distance between the red laser marks in photos D–F is 10 cm.

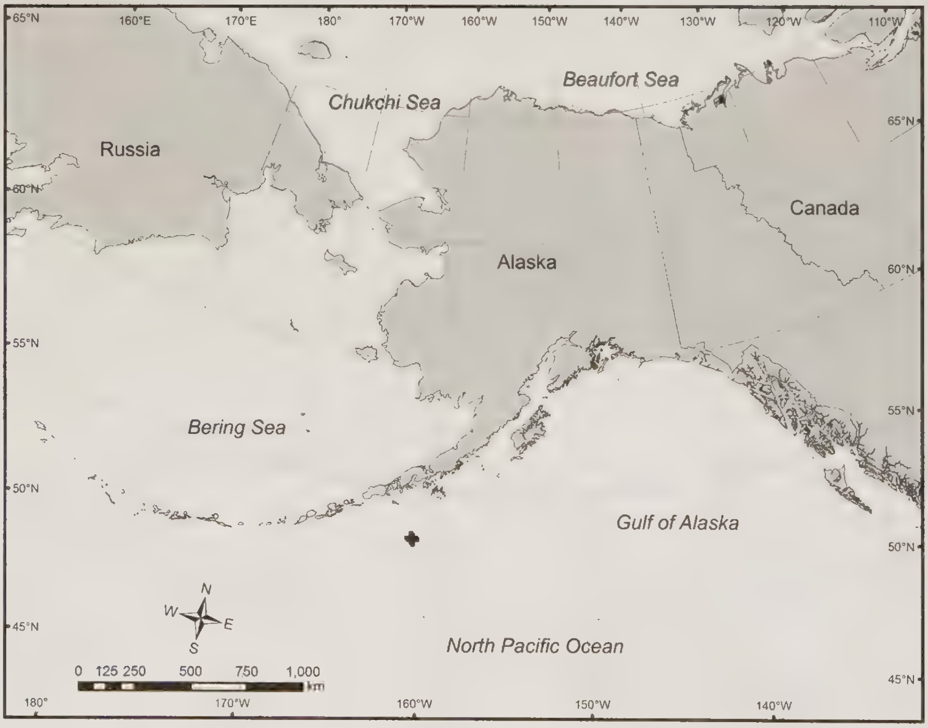
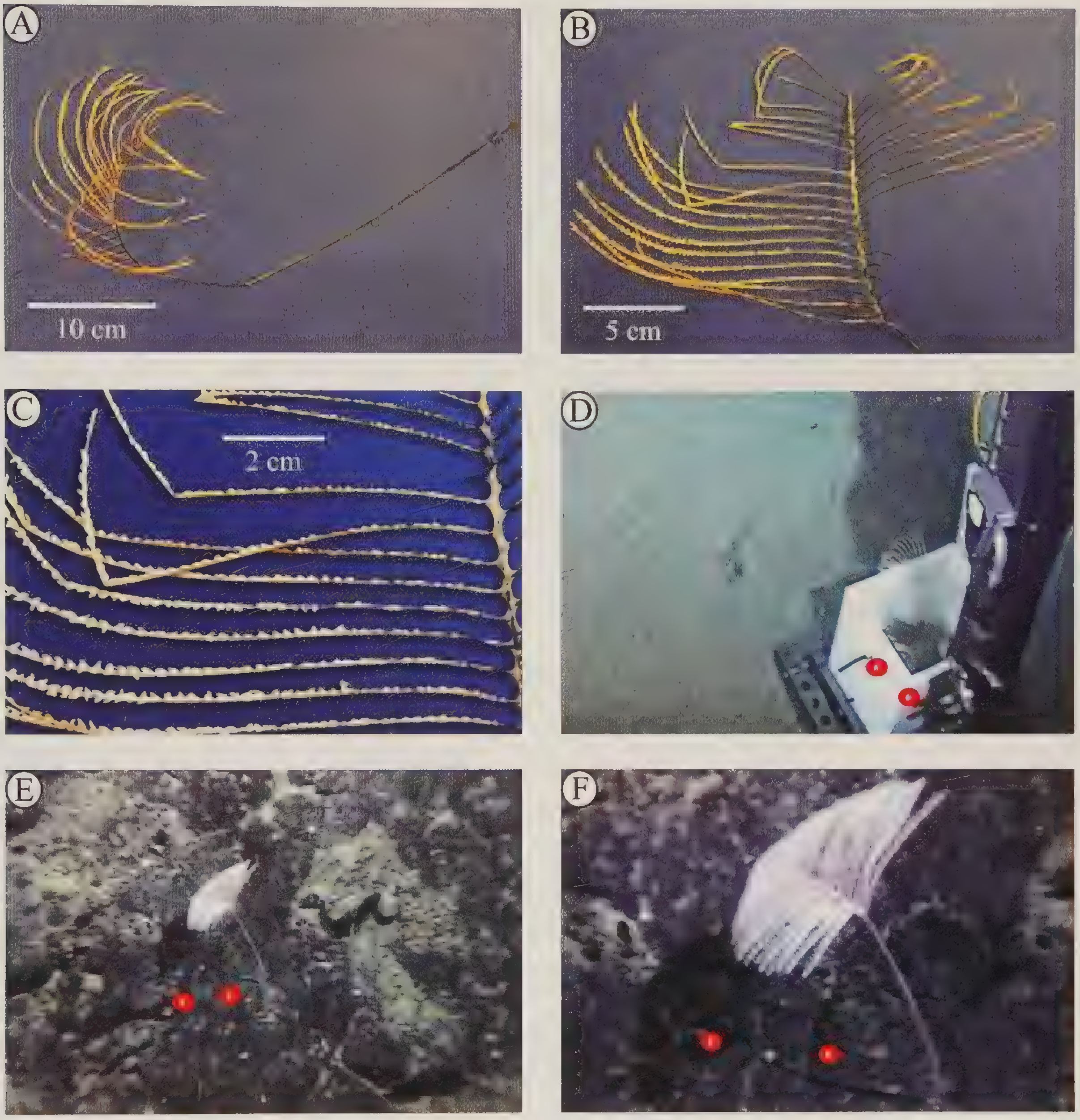


Figure 2-8

A map of the North Pacific Ocean showing the distribution of *Alternatipathes mirabilis* (+) in Alaska waters.


A
10 cm
B
5 cm
C
2 cm
D
E
F

6. *Bathypathes alaskensis* Opresko and Molodtsova, 2021

Description (Adapted from Opresko and Molodtsova, 2021) Colonies are monopodial and unbranched, but pinnulate. Colonies are up to about 43 cm in height with a basal stem diameter up to 2 mm. The stem is straight or curved but usually not distinctly sickle-shaped. Smaller colonies are usually upright or only slightly curved away from the polypar side of the corallum, whereas larger colonies tend to be strongly curved away from the polypar side. The unpinnulated stalk is typically 6.5–10.0 cm in length, while the pinnulated section is often >30 cm in length. Pinnules are simple, arranged along the stem in two lateral or anterolateral rows, and grouped in subopposite pairs (see Fig. 2-3E for a generic example). Pinnular density typically ranges 12–16 pinnules/5 cm. Pinnules are up to about 23 cm in length in the largest colonies (43 cm in height). The longest pinnules are usually found along the lower or middle part of the pinnulated section of the stem. The interior angle formed by the two rows of pinnules is highly variable; ranging from about 30° to 180° even within the same colony. The distal angle of pinnules is mostly 60–80° (range 45–90°).

Spines are smooth, simple, and conical with a rounded apex. The largest polypar spines on pinnules are mostly 0.11–0.14 mm in height. Spines are often bilobed or trilobed at the apex, eventually forming double and triple spines. Five to seven rows of spines are visible in lateral view of the pinnules.

Polyps are uniserially arranged; mostly 4–5 mm in transverse diameter (range 3–6 mm) as measured from the distal edge of the distal lateral tentacles to the proximal edge of the proximal lateral tentacles. Polyp density is 4–5 polyps/2 cm.

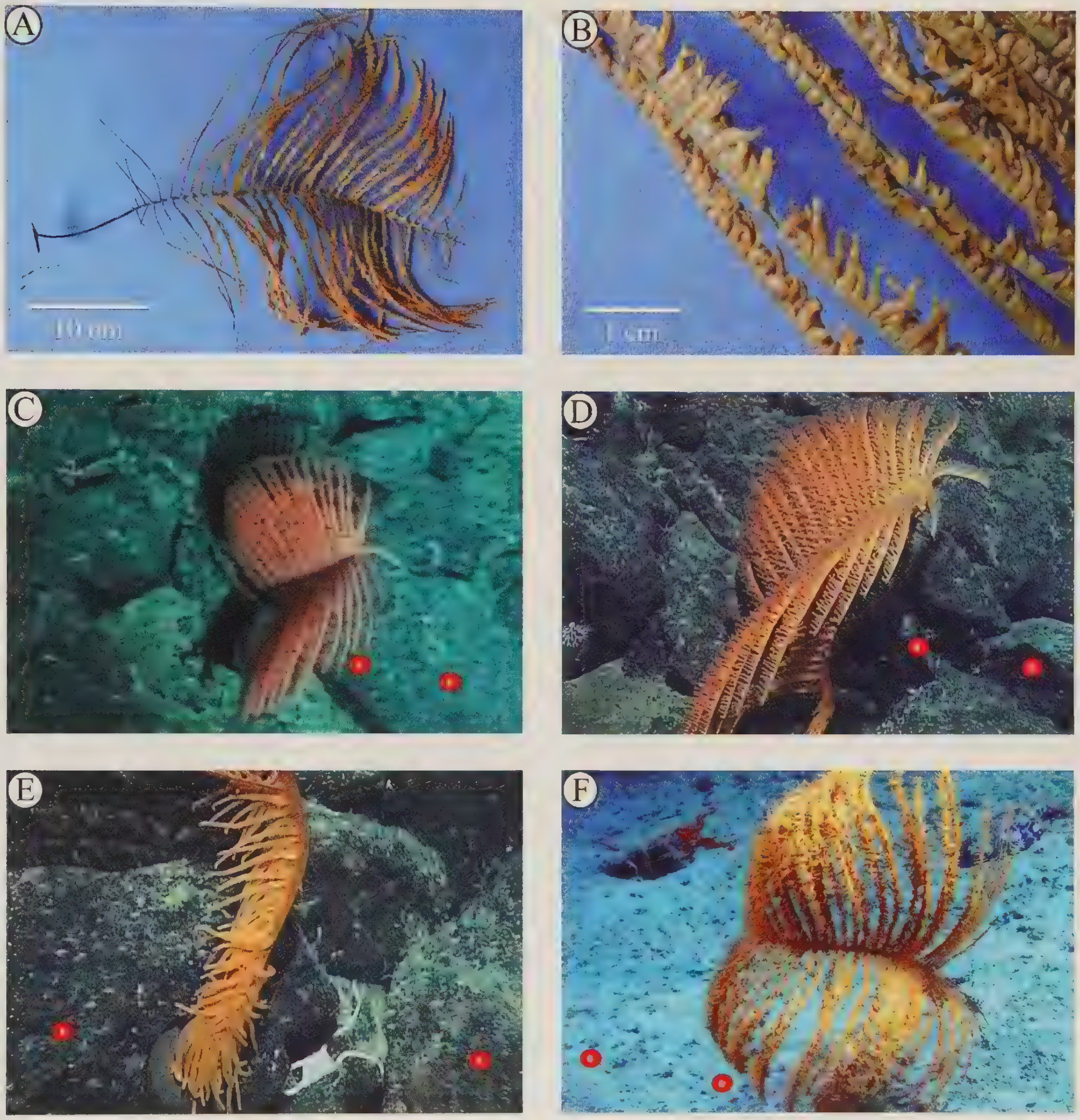
Colonies have large (up to 2 cm in diameter) circular holdfasts that are often conspicuously greyish in color and typically bear relatively large (>2 cm) sweeper tentacles on the entire unpinnulated section of the stem (photo E). This is the only antipatharian in Alaska that often bears sweeper tentacles (*Bathypathes patula* rarely bears sweeper tentacles); the only other coral in Alaska with sweeper tentacles is the keratoisidid *Isidella tentaculum* Etnoyer, 2008. The typical color of the coenenchyme in life is dark orange but occasionally lighter orange; color in ethanol is dull orange. This species attracts swarms of euphausiids.

Remarks Many of the Alaska specimens assigned to this newly described species were originally identified as *Bathypathes patula* Brook, 1889. The new species differs from *B. patula* in having 1) a stem that is not as distinctly sickle-shaped, 2) relatively longer pinnules, 3) larger and more numerous conical spines that can be bilobed or trilobed, 4) more rows of spines, and 5) slightly smaller and more densely arranged polyps. This species is also similar to *B. galatheae* Pasternak, 1977, a species also found in the North Pacific Ocean but not in Alaska, and differs in having smaller spines (0.08–0.14 mm versus 0.18–0.26 mm) and more flexible pinnules.

Distribution Common and locally abundant. In Alaska – principally in the eastern Gulf of Alaska including the inside waters of Southeast Alaska, the Gulf of Alaska Seamount Province (Dickens, Densen, Welker, and Pratt Seamounts), and a single specimen from the central Aleutian Islands (Fig. 2-9). Elsewhere – known from only two specimens: one collected on the continental slope off Washington and another from Monterey Canyon (northern California).

Habitat Found singly or in low-density patches. Attaches principally to siltstone but occasionally on bedrock and fractured bedrock, including basalt pillow lavas, at depths between 329 and 1837 m. Elsewhere – found at depths between 1215 and 1798 m.

Photos A) A preserved (in ethanol) whole *B. alaskensis* colony (USNM 1288462) collected in the eastern Gulf of Alaska at a depth of 515 m. B) A close-up view of a preserved (in ethanol) *B. alaskensis* specimen (USNM 1070916) collected on Densen Seamount at a depth of 1386 m. C) A *B. alaskensis* colony (USNM 1070919) in situ prior to collection on Pratt Seamount at a depth of 1837 m. D) A lateral view of the same colony in photo C. E) The same colony in photo C with a close-up view of the sweeper tentacles and grey-colored holdfast. F) A *B. alaskensis* colony (USNM 1288461) collected in the eastern Gulf of Alaska at a depth of 515 m. The distance between the red laser marks in photos C–F is 10 cm.


A
10 cm
B
1 cm
C
D
E
F

6. *Bathypathes alaskensis* Opresko and Molodtsova, 2021 (continued)

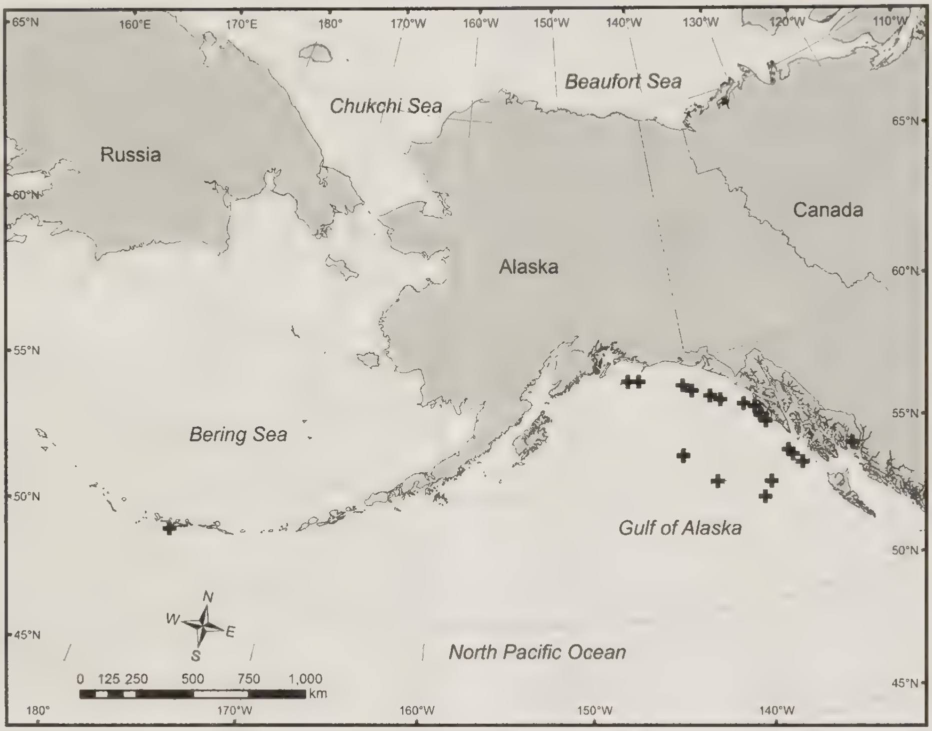

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
Canada
Alaska
60°N
55°N
Bering Sea
50°N
Gulf of Alaska
45°N
N
W
E
S
North Pacific Ocean
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W

Figure 2-9

A map of the North Pacific Ocean showing the distribution of *Bathypathes alaskensis* (+) in Alaska waters.

7. *Bathypathes patula* Brook, 1889

Description Colonies are monopodial and unbranched, but pinnulate. Colonies are up to 30 cm or more in height and the stem usually has a sickle-shaped curvature. The unpinnulated stalk is of varying length. Pinnules are simple (without subpinnules); arranged along the length of the stem biserially in two lateral or anterolateral rows, and grouped in subopposite pairs (see Fig. 2-3E for an example). Pinnules in each lateral row are spaced up to 12 mm apart. Pinnular density along the stem is mostly 6–8 pinnules/3 cm (total for both rows). The longest pinnules are found along the lower or middle part of the pinnulated section of the stem. Maximum length of pinnules is about 8 cm in colonies with 10 pairs of pinnules, but longer in larger colonies.

Spines on the stem and pinnules are simple, smooth, triangular, and laterally compressed. Spines are slightly larger on the polyp side of the axis. On pinnules 0.20–0.25 mm in diameter, the polypar spines are up to 0.07 mm in height and the abpolypar spines are 0.02–0.04 mm in height. On older colonies with thicker pinnules, polypar spines are up to about 0.1 mm in height and the abpolypar spines are 0.03–0.05 mm shorter than the polypar spines. Typically, only three rows of spines are visible in a lateral view of the pinnules.

Polyps are usually 5–7 mm in transverse diameter as measured from the distal edge of the distal lateral tentacles to the proximal edge of the proximal lateral tentacles; the polyp density along the length of a pinnule is approximately 2.5 polyps/2 cm. Live polyps are nearly translucent.

The holdfast is relatively inconspicuous but strong and the unpinnulated section of the stem rarely bears small sweeper tentacles. The color of the coenenchyme in life is yellowish orange to pinkish orange and a darker orange in ethanol.

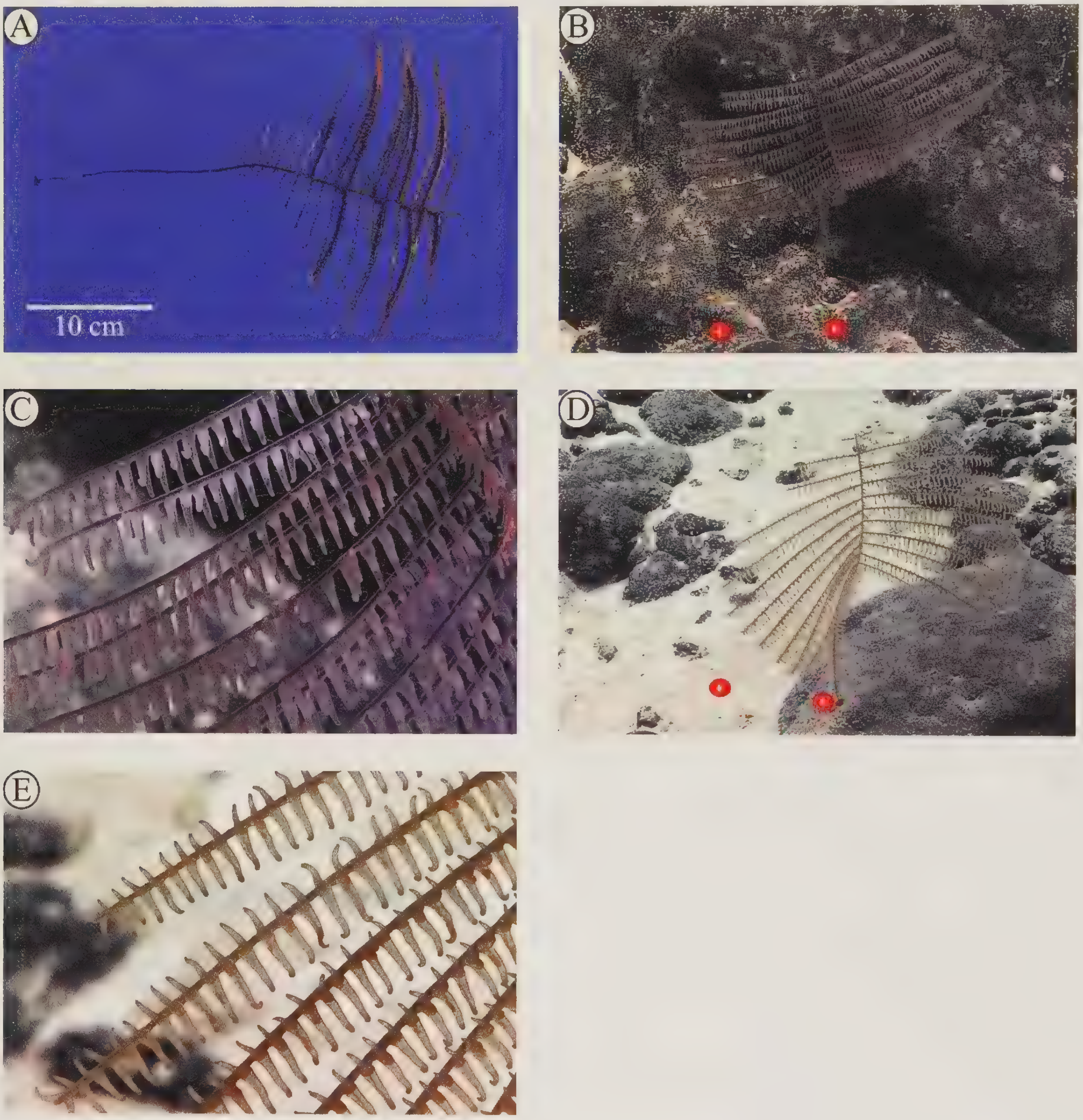
Remarks The type specimen of *B. patula* (NHMUK 90.4.9.19) collected in the North Pacific Abyssal Province is a whole colony about 20 cm in height with relatively short pinnules (approximately 8 cm) and spines not more than 0.07 mm in height. This species is known from only one specimen in Alaska and it has longer pinnules and slightly taller spines than the type specimen.

Distribution Rare. In Alaska - known from only one specimen (consisting of only fragments) collected on the deep abyssal plain south of the Aleutian Trench in the western Gulf of Alaska (Fig. 2-10). Elsewhere – reportedly cosmopolitan and wide ranging (North and South Pacific, Antarctica, North Atlantic, and Mediterranean and Caribbean Seas) but designations are likely to be revised with further study of the genus.

Habitat Grows singly on bedrock and fractured bedrock (cobble-size) at depths near 4950 m. This is a deeper water species than *B. alaskensis*. Elsewhere – eurybathic; on fractured basalt and pillow lavas. The type specimen was collected at a depth near 5200 m. Other reported specimens from the Pacific Ocean range in depth from 320 m (Hawaii) to 5020 m (Kurile-Kamchatka Trench, Russia).

Photos A) A preserved (in ethanol) whole *B. patula* colony (USNM 1453622) collected near American Samoa in the central Pacific Ocean at a depth of 3683 m. B) The same specimen in photo A in situ just prior to collection. C) A close-up view of the same specimen in photo B. D) A *B. patula* colony (USNM 1467584) just prior to collection in the Musician Seamounts, Hawaii. E) A close-up view of the same colony in photo D. The distance between the red laser marks in photos B and D is 10 cm. Photos B–E are courtesy of the National Oceanic and Atmospheric Administration's Office of Ocean Exploration and Research.

7. *Bathypathes patula* Brook, 1889 (continued)



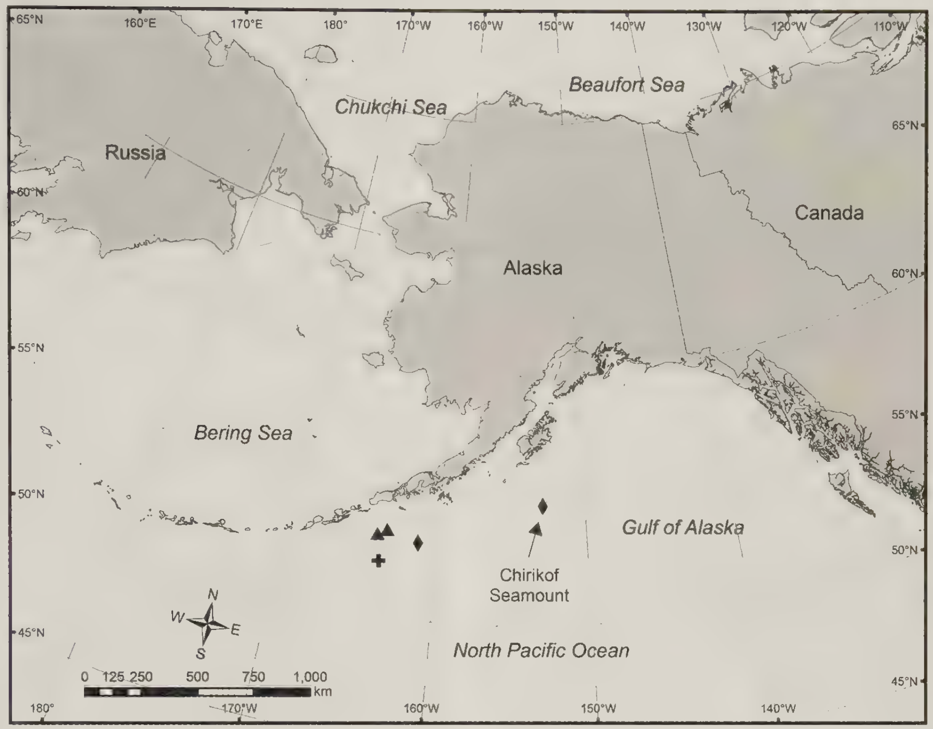

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
60°N
65°N
Canada
Alaska
60°N
55°N
Bering Sea
55°N
50°N
Gulf of Alaska
50°N
Chirikof
Seamount
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 2-10

A map of the North Pacific Ocean showing the distribution of *Bathypathes patula* (+), *B. ptiloides* (◆), and *B. tiburonae* (▲) in Alaska waters.

8. *Bathypathes ptiloides* Opresko and Molodtsova, 2021

Description (Adapted from Opresko and Molodtsova, 2021) Colonies are monopodial, unbranched, and pinnulate. Colonies are to at least 78 cm in height, about 40 cm in width, with a basal diameter of the stem up to 2 mm. Coralla consist of a very long unpinnulated stalk, up to 66 cm in length, topped by a short pinnulated section only 10–20 cm in length. The lower section of the stem is inclined towards the polyp side of the colony and then more strongly curved in the same direction, after which it curves in the opposite direction such that the upper part of the pinnulated section is almost vertical. The pinnulated section of the colony is quite convex and occasionally lies more or less horizontally in the water column.

Pinnules are simple, arranged along the stem in two lateral or anterolateral rows, and in subopposite pairs (see Fig. 2-3E for a generic example). Pinnules are to at least 12 cm in length and spaced 6–13 mm apart in each lateral row. Pinnular density (total for both rows) is 6 pinnules/3 cm on the lowermost pinnulated portion of the stem and 8 pinnules/3 cm distally. The pinnules are inclined distally such that the distal angle they form with the stem is 70–80°. Interior angle formed by the two rows of pinnules is 120° or more.

Spines are simple, smooth, triangular in lateral view, compressed, with a rounded apex and a base that extends out in a very shallow slope in both the distal and basal directions. Polypar spines are up to 0.04 mm in height and abpolypar spines are 0.035 mm tall. Six rows of spines are visible in one lateral view.

Polyps are uniserially arranged on one side of the corallum; 6–8 mm in transverse diameter, with 3 polyps/3 cm. Polyps on the stem are 7 mm in transverse diameter.

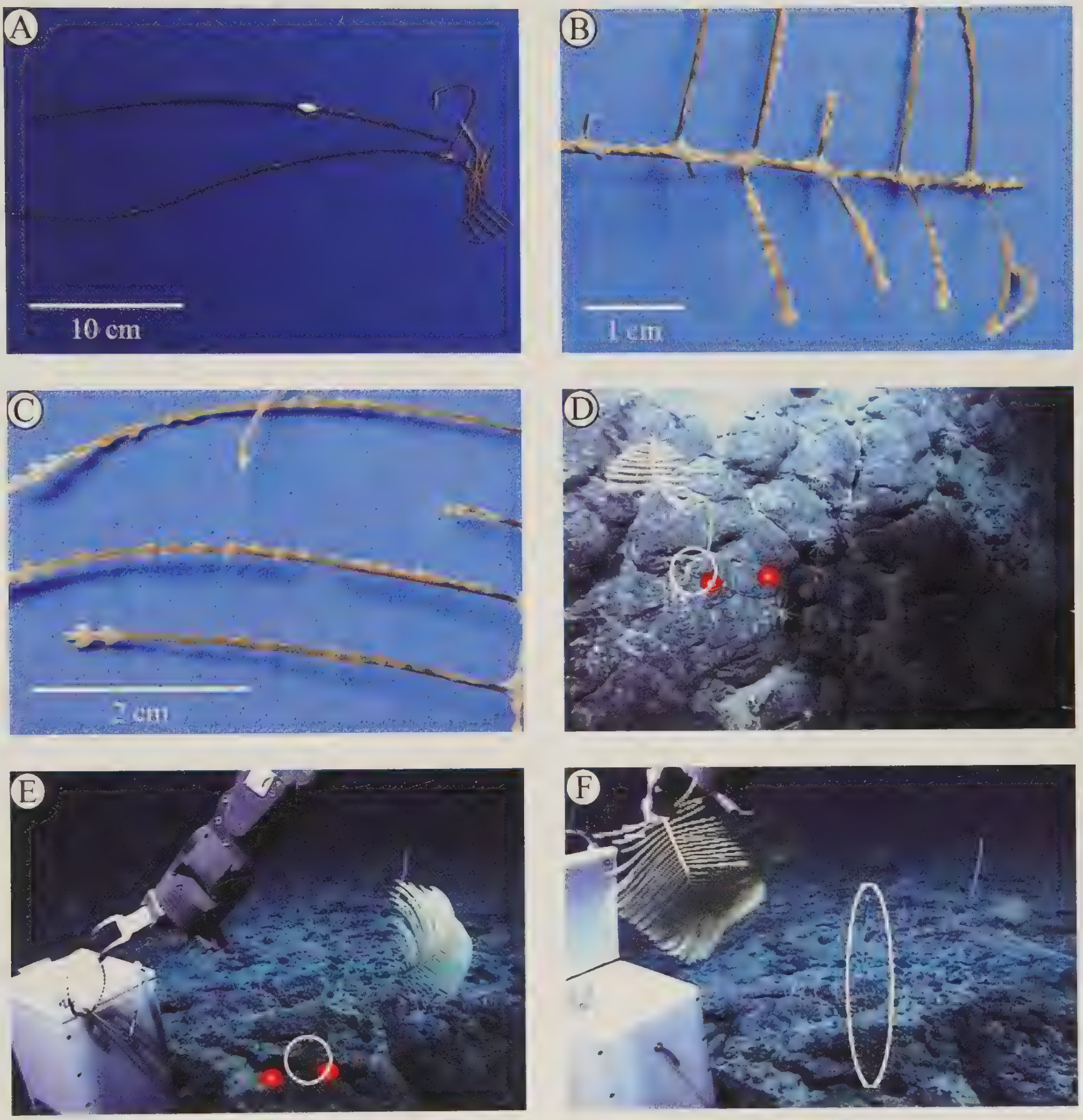
The holdfast is small and inconspicuous but firmly attached to the substrate. Color in situ is orange to light orange; creamy orange in ethanol.

Remarks This species differs from *Bathypathes patula* in having a longer unpinnulated section of the stem, larger polyps, relatively longer pinnules, and smaller spines. It differs from *B. alaskensis* in having larger polyps, but smaller spines. This species is superficially quite similar to *Alternatipathes mirabilis* with which it co-occurs but the pinnulated section of the colony is much longer and not as obviously triangular-shaped.

Distribution Uncommon but locally abundant. In Alaska – known from only two specimens; one collected on Chirikof Seamount and the second collected on Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 2-10). At both locations multiple video observations were made indicating that this species is locally common and occurs at patch densities up to 3 colonies/m^2. Elsewhere – not reported.

Habitat Forms small scattered patches (up to 25 colonies) on bedrock and fractured bedrock including basalt pillow lavas at depths between 4491 and 4676 m. Often occurs in association with the keratoisidid *Bathygorgia profunda* Wright, 1885.

Photos A) Preserved (in ethanol) large sections of a *B. ptiloides* colony (USNM 1070974) collected on Derickson Seamount at a depth of 2664 m. B) A close-up view of the same specimen in photo A. C) A zoomed-in view of the same specimen in photo A. D) The same colony in photo A with the holdfast visible (indicated by the white circle) just prior to collection. E) A *B. ptiloides* colony (USNM 1071408) with the holdfast visible in the center of the white circle. The top part of the colony was collected on Derickson Seamount at a depth of 4491 m. F) A close-up view of the collection of the top pinnulated section of the same colony in photo E. The stalk and holdfast are indicated by the white ellipse. The distance between the red laser marks in photos D and E is 20 cm.


A
10 cm
B
1 cm
C
2 cm
D
E
F

9. *Bathypathes tiburonae* Opresko and Molodtsova, 2021

Description (Adapted from Opresko and Molodtsova, 2021) Colonies are monopodial, unbranched, and pinnulate. Largest colonies measure up to 55 cm in height (total length of the stem), 30 cm in width, and the basal diameter of the stem is up to 3 mm. Coralla consist of an unpinnulated stalk up to 37 cm in length and topped by a pinnulated section only 18 cm in length. The stem is relatively straight and upright. Pinnules are simple, arranged along the stem in two lateral or anterolateral rows and in subopposite pairs (see Fig. 2-3E for a generic example). Pinnules are to at least 24 cm in length and spaced up to 10–18 mm apart in each lateral row. Pinnular density (total for both rows) is 4 pinnules/3 cm on the lowermost pinnulated portion of the stem and 6 pinnules/3 cm distally. The distal angle of the pinnules with the stem is about 80°. The interior angle formed by the two rows of pinnules is about 120° nearest to the stem.

Spines are simple, smooth, triangular in lateral view, and compressed with a rounded apex. Polypar spines are up to 0.09 mm in height and abpolypar spines are up to 0.08 mm in height. Five or six rows of spines are visible in one lateral view.

Polyps are uniserially arranged on one side of the corallum, mostly 9–10 mm (up to 12 mm) in transverse diameter, and there are 3 polyps/4 cm or 4–5 polyps/5 cm. The polyps on the stem are up to 17 mm in transverse diameter, with 2 polyps/4 cm.

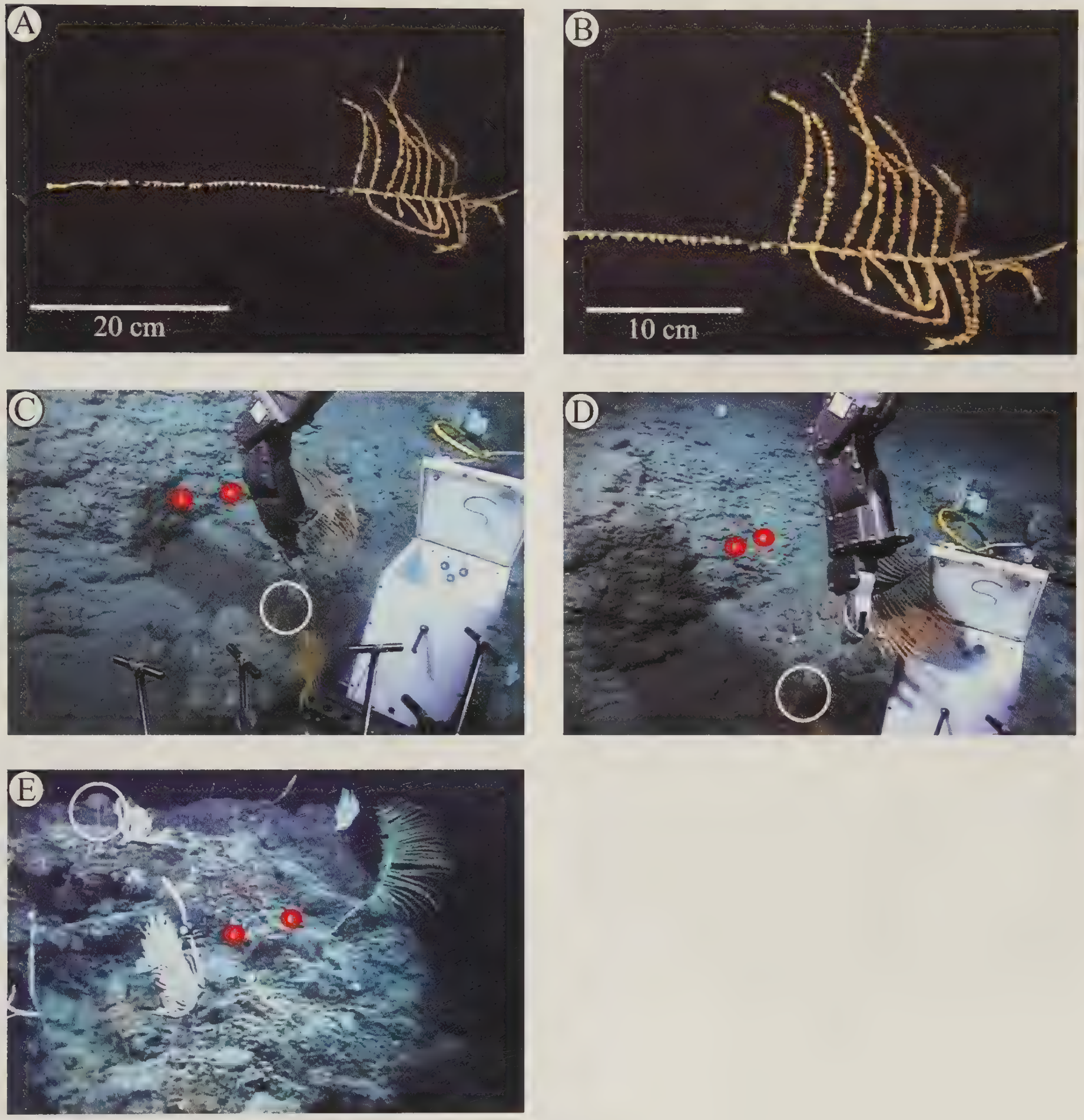
The holdfast is relatively small and elliptical but quite strong and firmly attached to the substrate. The color of the coenenchyme is orange to light orange in life and creamy orange in ethanol.

Remarks This species differs from *B. alaskensis* in having a longer unpinnulated stalk (about 67% of the total stem length compared to about 25% in colonies 40–55 cm in height); smaller polypar spines (0.09 mm in height compared to 0.11–0.14 mm in height), and larger polyps (up to 12 mm in diameter compared to only 3–6 mm in diameter). It differs from *B. patula* in having a longer unpinnulated stalk (about 67% of the total stem length compared to about 50% in *B. patula* of similar size), slightly larger polypar spines on the pinnules (up to 0.09 mm compared to ≤0.07 mm in height), and larger polyps (up to 12 mm compared to 5–7 mm). *Bathypathes tiburonae* is similar to *B. ptiloides* in having a long unpinnulated stalk, but it has larger pinnular spines (0.09 mm compared to 0.04 mm in height), and larger polyps (up to 12 mm compared to 8 mm in diameter).

Distribution Uncommon. In Alaska – known only from the deep continental slope south of Davidson Bank in the western Gulf of Alaska (Fig. 2-10). Elsewhere – also known from Gorda Ridge off northern California (USNM 1116837) and off Oregon (USNM 1234549).

Habitat Known from a single specimen collected on a large siltstone bank at a depth of 3356 m and three specimens observed nearby; one on the same bank as the collected specimen (see photo C) and two specimens on a large boulder at a depth of 3280 m (see photo E). Co-occurs with the keratoisidid *Bathygorgia profunda* and the primnoid *Narella bayeri* Cairns and Baco, 2007. Elsewhere – depths between 2516 and 3150 m.

Photos A) A large portion of a preserved (in ethanol) *B. tiburonae* colony (USNM 1116837; holotype) collected on southern Gorda Ridge off northern California at a depth of 3121 m. B) A close-up view of the same specimen in photo A. Photos A and B are reprinted with permission from Zootaxa. C) A *B. tiburonae* colony (USNM 1459868) collected near Davidson Bank in the western Gulf of Alaska at a depth of 3356 m. The holdfast is visible in the center of the white circle. Note the second colony present below the white circle. D) The same colony in photo C during collection near Davidson Bank in the western Gulf of Alaska at a depth of 3356 m. The holdfast (not collected) is visible in the center of the white circle. E) Two *B. tiburonae* colonies (a large colony just right of the laser marks and a smaller one at the center of the white circle) observed near Davidson Bank at a depth of 3280 m. The distance between the red laser marks in photos C–E is 20 cm.


A
20 cm
B
10 cm
C
D
E

10. *Bathypathes* sp. A

Description The collected colony is monopodial, unbranched, and pinnulate with a maximum length of about 36 cm (estimated from in situ photos). The shape of the stem is unknown but it appears to be relatively straight, stout, and flexible. The unpinnulated stalk is approximately 25% of the total colony length. Pinnules are simple (without subpinnules) and arranged along the stem biserially in two anterolateral rows. The longest pinnules are about 12 cm (estimated from in situ photos).

Spines are simple, smooth, triangular to conical, and 0.025–0.050 mm in height. Polyps are small, mostly 3.5–5.5 mm in transverse diameter, with a density of approximately 2 polyps/cm.

The holdfast is relatively large, circular, covered with a very thin coenenchyme, and firmly attached to the substrate. Color of the coenenchyme in life is a uniform light orange.

Remarks Only pinnules and in situ photos of the single collected specimen were available for examination. This species differs from other known *Bathypathes* spp. in having relatively small spines as well as very small polyps. Although *B. patula* and *B. ptiloides* both have spines of a similar size, the polyps of these two species are larger: 6–8 mm or more in transverse diameter. In addition, the pinnular density in this species, approximately 14 total pinnules/3 cm (estimated from in situ photos), appears to be greater than in any other Alaska *Bathypathes* spp., including *B. alaskensis* which has 8–12 pinnules/3 cm. However, an exact measurement cannot be made because of the orientation of the colony shown in the photos. Compared to *Bathypathes alaskensis*, this species has pinnules that appear to be shorter and stiffer and the coenenchyme is a lighter color.

This species occurs in habitats with tube-dwelling polychaetes (family Sabellidae), hydroids, and the keratoisidid coral *Bathygorgia profunda,* and it harbors ophiuroids.

Distribution Rare. In Alaska – known from only a single specimen collected south of Davidson Bank in the western Gulf of Alaska (Fig. 2-11). Elsewhere – unknown.

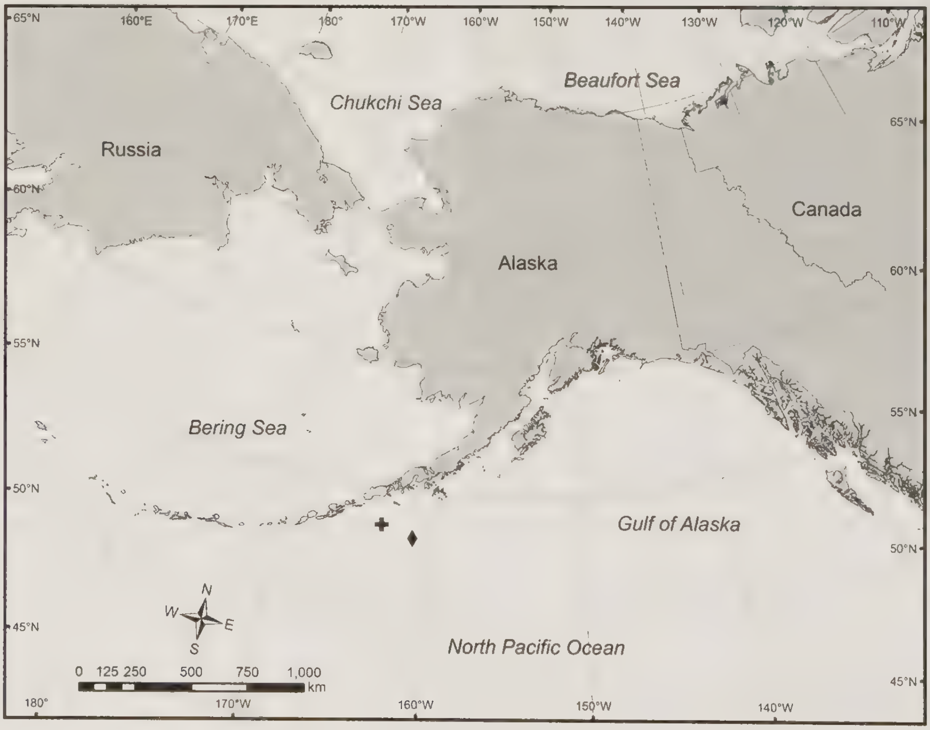
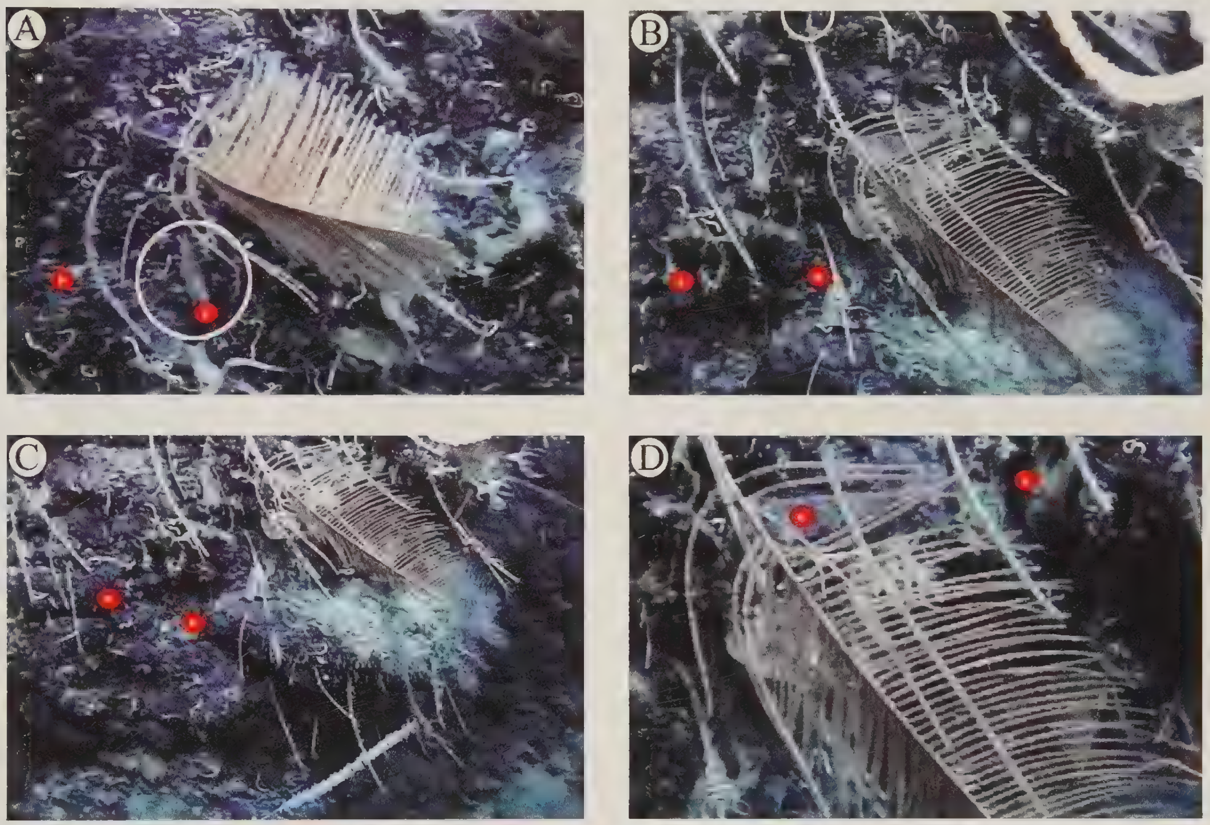


Figure 2-11

A map of the North Pacific Ocean showing the distribution of *Bathypathes* sp. A (+) and *Bathypathes* sp. B (◆) in Alaska waters.

Habitat Occurs singly (although see photo A below) in areas of rough conglomerate (largely fragmented basalt) at depths near 3275 m.

Photos A) A *Bathypathes* sp. A colony (USNM 1071406) collected south of Davidson Bank in the western Gulf of Alaska at a depth of 3275 m. A second smaller colony (indicated by the white circle), likely the same species, grows nearby. B) The same colony in photo A with the holdfast visible in the white circle at the top of the photo. C) A broad view of the same colony in photo A. D) A close-up view of the pinnulated section of the same colony in photo A. The distance between the red laser marks in photos A–D is 10 cm.



11. *Bathypathes* sp. B

Description The collected colony is monopodial, unbranched, and pinnulate. The colony is about 36 cm in height and the stem near the base has a diameter of only about 3 mm. The stem is curved but not sigmoidal. The unpinnulated stalk is very short (11 mm in length) which is quite unusual for any species of *Bathypathes*. Note that in photos A and B (below) pinnules appear to be growing directly from the holdfast but that is an artifact of the photographs. Pinnules are simple (without subpinnules) and arranged along the length of the stem biserially in two anterolateral rows and in a subopposite fashion. Pinnules are ≥24 cm in length with a basal diameter of about 1 mm. Pinnules are 7–10 mm apart, resulting in a pinnular density (total for both sides) of 6 pinnules/3 cm on the lower part of the corallum and 8–10 pinnules/3 cm on the upper part.

The spines are simple, smooth, triangular, laterally compressed, and with a shallow slope on the distal and proximal edges. The polypar spines are 0.04–0.07 mm in height whereas the abpolypar spines are 0.02-0.03 mm in height. Five to seven rows of spines are visible in lateral view, with 4 spines/mm in each row.

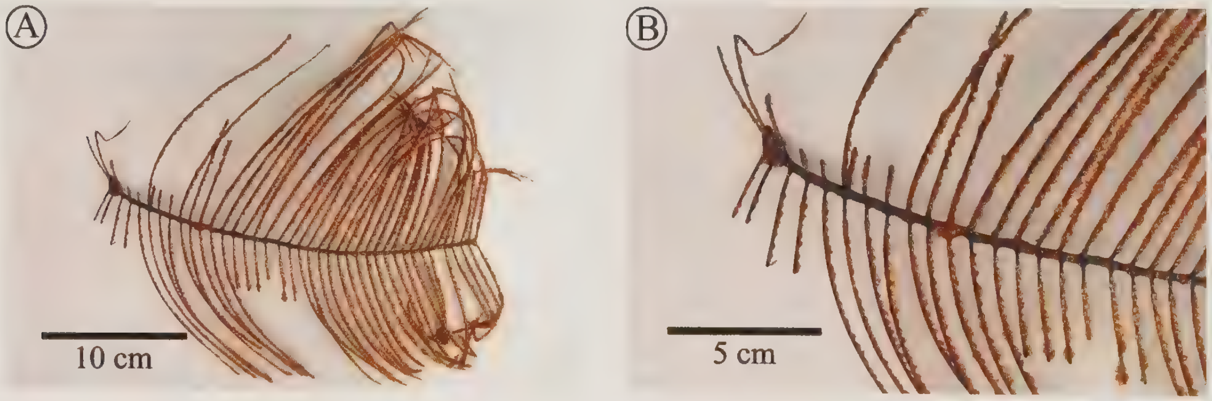
The polyps are 7–8 mm in transverse diameter, with a density of 2.0–2.5 polyps/2 cm. The holdfast is small, cup-shaped, and firmly attached to the substrate. The color of the coenenchyme in life is light orange and a lighter orange in ethanol.

Remarks This species is unique from other nominal species of *Bathypathes* in that the unpinnulated stalk is very short (only about 11 mm in length). Most species of *Bathypathes* have unpinnulated stalks of 7 cm or more. The very short unpinnulated stalk of the colony may be an abnormal condition resulting from an injury followed by regrowth of the sclerenchyme and formation of the pinnules near the base. In terms of the size and shape of the pinnular spines and length of the pinnules, this species is similar to *B. tiburonae,* but in terms of the size and density of the polyps it is more similar to *B. ptiloides* with which it co-occurs.

Distribution Rare. In Alaska – known from only one specimen (USNM 1070973) collected on Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 2-11). Elsewhere – unknown.

Habitat Occurs singly on fragmented bedrock (basalt) at a depth of 4497 m.

Photos A) A preserved (in ethanol) whole *Bathypathes* sp. B colony (USNM 1070973) collected on Derickson Seamount at a depth of 4497 m. B) A close-up view of the same specimen in photo A.



12. *Dendrobathypathes boutillieri* Opresko, 2005

Description (Adapted from Opresko, 2005) Colonies are generally wider (≥150 cm in width) than taller (≥95 cm in height). Coralla are extensively branched and pinnulate; the stem, branches, and primary pinnules are generally in one plane. Primary pinnules are arranged alternately along the stem and branches in two lateral to anterolateral rows, and occasionally with one (rarely two) simple secondary pinnules near the base (Fig. 2-3F). Primary pinnules within each anterolateral row are spaced 5–8 mm apart resulting in 3–4 pinnules/cm (total for both rows). The interior angle formed by rows of primary pinnules is near 90°. Primary pinnules are inclined distally, generally not more than 2 cm in length, and with a basal diameter of about 0.5 mm (excluding spines). Secondary pinnules are present on the anterior (polypar) side of the primaries near the base and project out from the polypar side of the corallum. Secondary pinnules are usually not more than about 1 cm in length with basal diameter of not more than 0.4 mm. Secondary pinnules are inclined towards the distal end of the primary pinnule from which they arise. Tertiary pinnules are not present.

Pinnular spines are simple (rarely forked), conical, with a rounded to somewhat acute apex, and slightly compressed; subequal to slightly larger on one side of the axis (usually but not always corresponding to the polypar side). Polypar spines are mostly 0.10–0.14 mm but up to 0.18 mm in height; abpolypar spines are generally 0.02–0.04 mm shorter than polypar spines. Most spines project out at right angles to the axis, but some are angled slightly towards the base of the pinnule on which they occur. Spines are not always arranged in regular longitudinal rows, four to six of which are usually visible in lateral view. Spines are spaced apart within each row at varying distances, from about 0.35 mm to as much as 0.75 mm, but generally there are 3–4 spines/mm in each row.

Polyps occur on one side of the corallum, corresponding to the side on which the secondary pinnules are located. Polyps are mostly 3.5–5.0 mm in transverse diameter (as measured from the distal edge of the distal lateral tentacles to the proximal edge of the proximal lateral tentacles). Polyp density is 2–3 polyps/cm. Tentacles are relatively thick and blunt, and about 2 mm in length in preserved samples.

Larger colonies have a massive (up to 8×3 cm), asymmetrical, very strong holdfast typically covered with coenenchyme and with a characteristic black stain on the substrate surrounding the holdfast (see photo D on next page). Color of flesh in life is bright orange and orange-brown in ethanol preserved specimens.

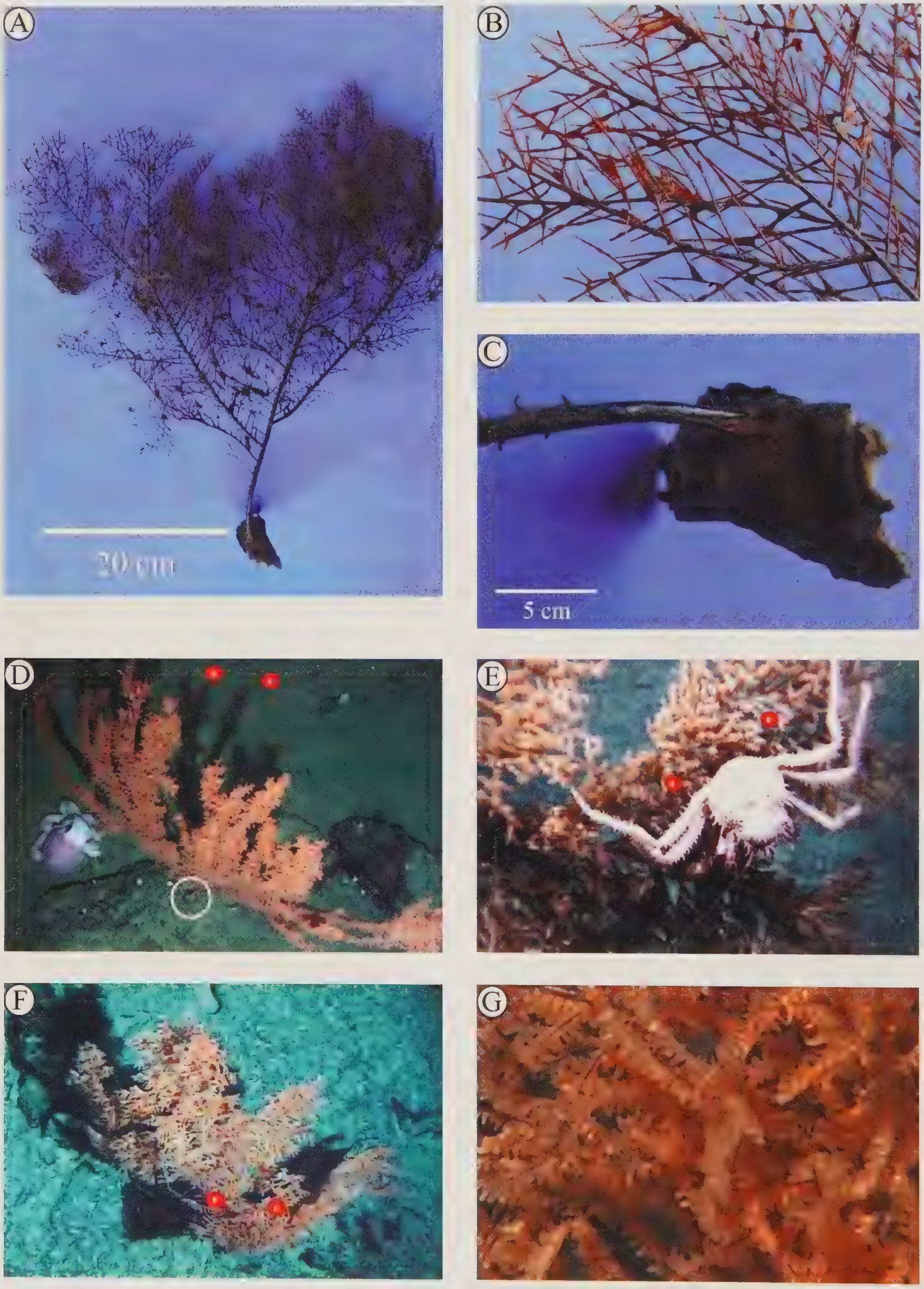
Remarks Larger colonies of *D. boutillieri* are often used as an elevated perch by king crabs (*Paralomis* spp.).

Distribution Uncommon but widespread. In Alaska – eastern Gulf of Alaska, central Aleutian Islands (southwest of Amlia Island to Adak Canyon), and Giacomini Seamount in the Gulf of Alaska Seamount Province (Fig. 2-12). Elsewhere – northern British Columbia.

Habitat Found singly on bedrock, siltstone, and boulders. Collected specimens range in depth from 932 to 2161 m but video observations indicate the species ranges to depths as shallow as 859 m in the central Aleutian Islands (Stone, 2014). Elsewhere – collected at depths between 1903 and 1908 m.

Photos A) A dried whole *D. boutillieri* colony (USNM 1094105) collected off British Columbia at a depth of 1460 m. B) A close-up view of the same specimen in photo A. C) A close-up view of the holdfast on the same specimen in photo A. D) A *D. boutillieri* colony (USNM 1093060) sampled in the central Aleutian Islands at a depth of 2019 m. Note the characteristic black stain around the holdfast indicated by the white circle. The octopus, *Graneledone boreopacifica,* takes refuge under the colony. The distance between the red laser marks is 20 cm. E) A *D. boutillieri* colony (USNM 1093057) sampled in the central Aleutian Islands at a depth of 2161 m. A spiny paralomis (*Paralomis multispina*) perches in the colony. F) A view of the top of a *D. boutillieri* colony (USNM 1070762) sampled on Giacomini Seamount at a depth of 1689 m. The distance between the red laser marks in photos E and F is 10 cm. G) A close-up view of the branches and polyps on the same colony in photo F.

12. *Dendrobathypathes boutillieri* Opresko, 2005 (continued)


A
20 cm
B
C
5 cm
D
E
F
G

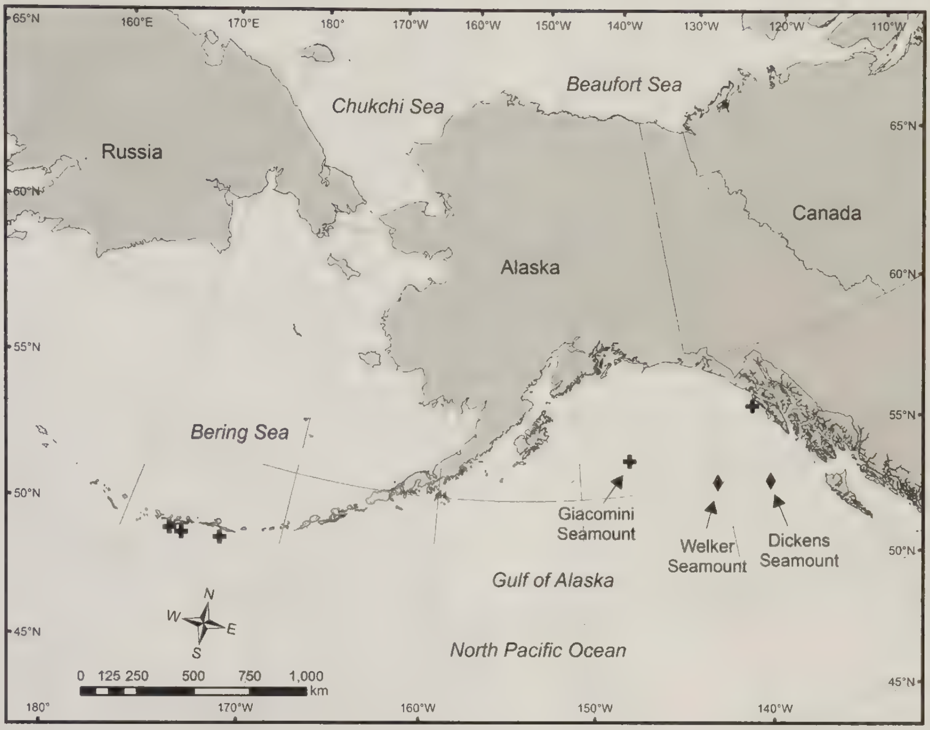

Russia
Chukchi Sea
Beaufort Sea
Alaska
Canada
Bering Sea
Giacomini Seamount
Welker Seamount
Dickens Seamount
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 2-12

A map of the North Pacific Ocean showing the distribution of *Dendrobathypathes boutillieri* (+) and *Dendrobathypathes* sp. (♦) in Alaska waters.

13. *Dendrobathypathes* sp.

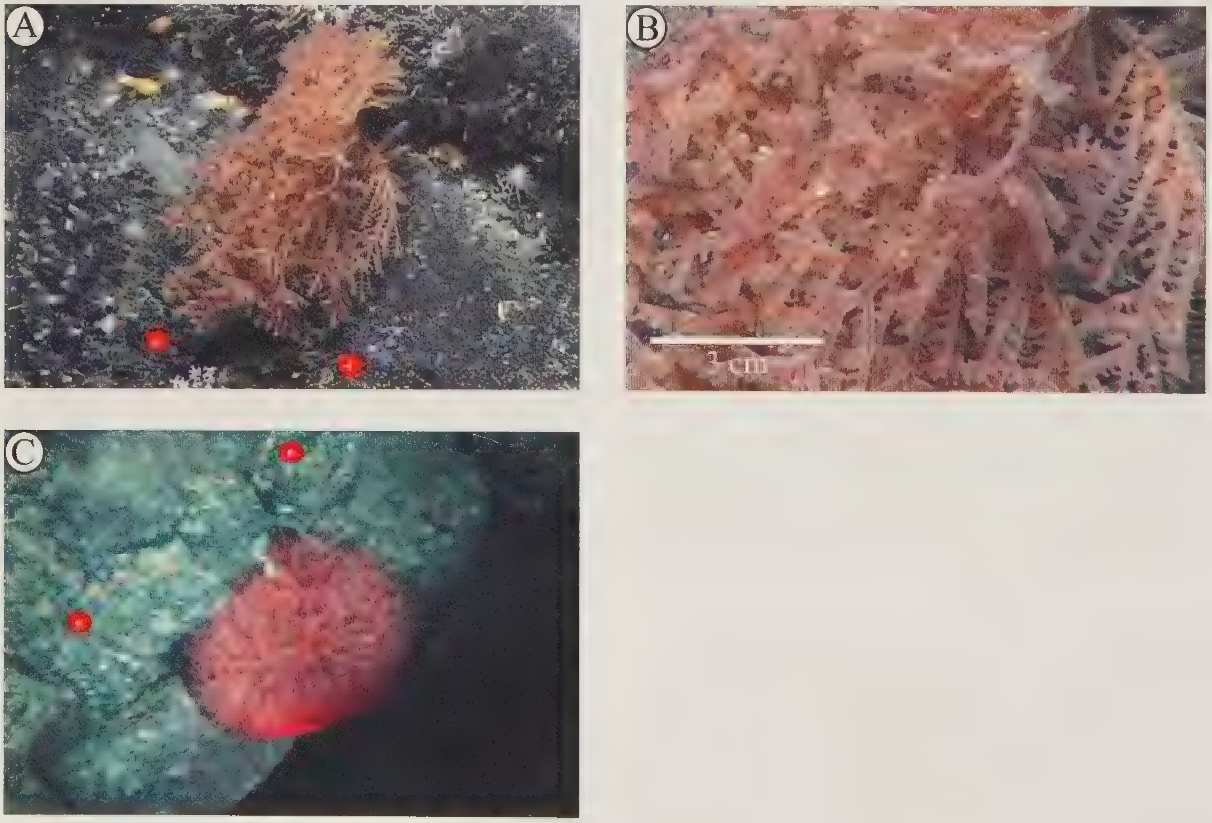
Description Colonies are most similar to *Dendrobathypathes boutillieri* (especially specimen USNM 1070762 collected on Giacomini Seamount at 1689 m depth) but with denser branching, longer primary pinnules, and very few subpinnules. Colonies are bushy, flexible, not rigid, and have a very floppy or creeping appearance. Colonies are to about 15 cm in length, 10 cm in width, and 9 cm in diameter. Color of the coenenchyme is pinkish-orange with only parts of the underlying corallum visible.

Remarks This taxon is known only from video footage of four specimens observed together (within 1 m of each other) on Welker Seamount and a fifth specimen observed on nearby Dickens Seamount. It is unlike any other antipatharian known in the region in that it is not arborescent but has more of a creeping habitus. It undoubtedly represents an unknown species and should be a high priority for collection.

Distribution Extremely rare. In Alaska – known from only four specimens observed on Welker Seamount and one specimen observed on Dickens Seamount in the Gulf of Alaska Seamount Province (Fig. 2-12). Elsewhere – unknown.

Habitat Found singly or in clusters of up to four individuals on sloped habitat of bedrock and fractured bedrock at depths of 1652–2634 m.

Photos A) A *Dendrobathypathes* sp. colony photographed on Welker Seamount at a depth of 2634 m. B) A close-up view of the same colony in photo A. C) A *Dendrobathypathes* sp. colony photographed on Dickens Seamount at a depth of 1652 m. The distance between the red laser marks in photos A and C is 10 cm.



14. *Lillipathes wingi* Opresko, 2005

Description (Adapted from Opresko, 2005) Coralla are unbranched or sparsely to moderately branched, mostly in one plane, with up to six branches (see photo A on next page). Colonies are to at least 150 cm in height and up to 75 cm in width. The stem usually extends to the top of the corallum. The stem and branches are pinnulate. Pinnules are simple and without subpinnules; they are arranged in four rows along the length of the stem and branches, two lateral and two anterior, and also in alternating biserial groupings of two pinnules each (see Fig. 2-3G for a generic example). One or both anterior pinnules are occasionally missing. Anterior pinnules are inserted slightly below (1–2 mm) adjacent lateral pinnules. Pairs of pinnules on either side of the axis are 2.5–3.0 mm apart with 10–14 pinnules/cm (total for all rows). Pinnules on smaller branches are 1–2 cm in length. Pinnules on stem and larger branches are up to 5 cm in length with a basal diameter of about 0.4 mm. Generally, the lateral pinnules are longer than anterior pinnules by 5–10 mm; however, anterior pinnules are occasionally longer than adjacent lateral pinnules. The interior angle formed by the two rows of lateral pinnules is typically close to 180°, but slightly less near branch tips. The interior angle formed by two anterior rows increases from about 90° at the tips of branches to 120–150° basally. The distal angle of pinnules is 60–70°.

Spines are conical, simple, each with a rounded apex, and are larger on the polyp side of the axis. Polypar spines on pinnules are mostly 0.07–0.10 mm in height; abpolypar spines are 0.03–0.05 mm shorter. Double spines are occasionally present, especially on the polypar side of the axis. Four to six rows of spines are visible in lateral view on pinnules. Spacing of spines within each row is not uniform; the mutual distance is 0.18–0.37 mm, on average 0.30 mm, resulting in 4–5 spines/mm in a row. Polyps are 2.4–3.6 mm in transverse diameter.

Holdfasts are relatively small and irregular in shape, devoid of coenenchyme and firmly attached. The color of the coenenchyme in life is bright orange, creamy white in ethanol, and light orange when dried.

Remarks In situ observations of large specimens indicate that they often harbor ophiuroids including *Ophiacantha* sp. and swarms of euphausiids.

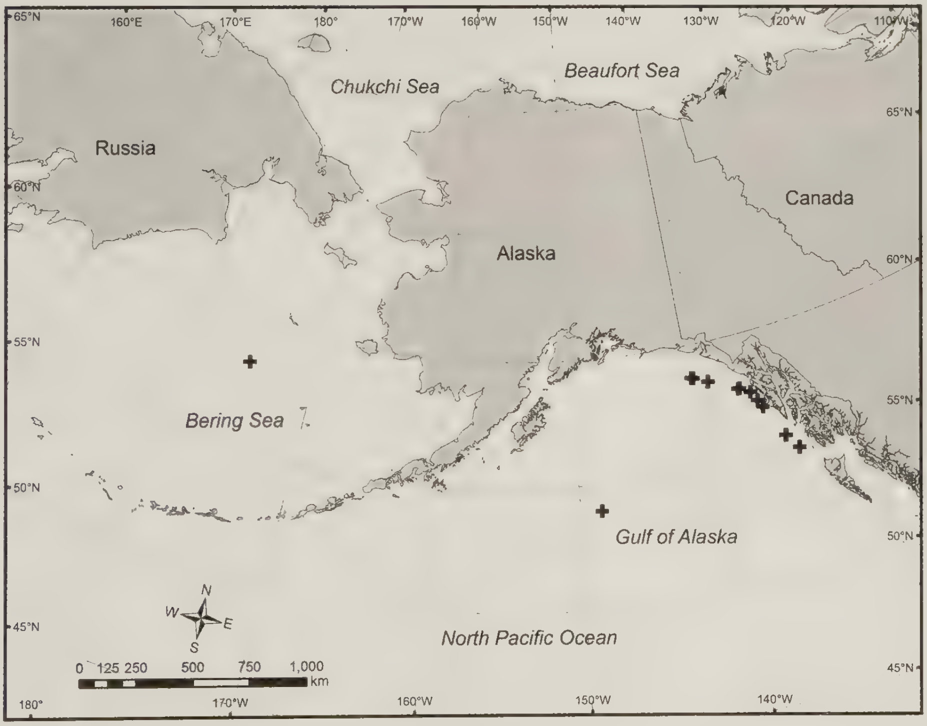


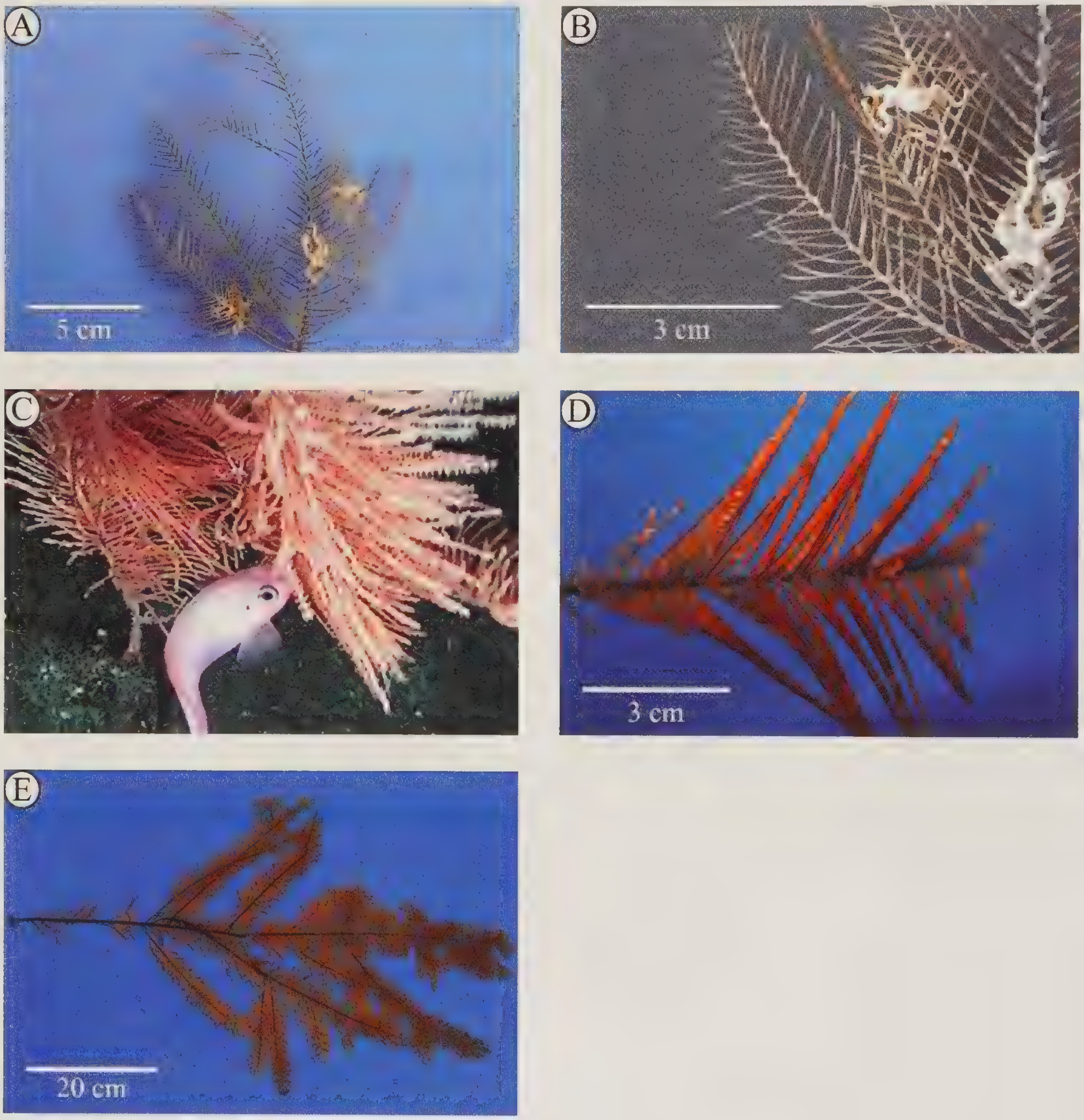
Figure 2-13

A map of the North Pacific Ocean showing the distribution of *Lillipathes wingi* (+) in Alaska waters.

Distribution Uncommon. In Alaska – this is predominantly a continental slope species. Specimens have been collected in the eastern Gulf of Alaska, a single seamount in the Gulf of Alaska Seamount Province (Murray Seamount), and the eastern Bering Sea (Fig. 2-13). Elsewhere – ranges south through British Columbia to Astoria Canyon (off the southwest coast of Washington).

Habitat Found on bedrock, siltstone, and cobbles at depths between 600 and 909 m. Elsewhere – collected at depths between 896 and 1903 m.

Photos A) A preserved (in ethanol) whole *L. wingi* colony (USNM 1094142) collected off northern British Columbia at a depth of 1057 m. B) A close-up view of the same specimen in photo A. C) A snailfish (*Careproctus* sp.) seeks refuge in a large, multi-branched *L. wingi* colony (USNM 1249983) sampled in Zhemchug Canyon in the eastern Bering Sea at a depth of 909 m. D) A branch (fresh) sampled from the colony in photo C. E) A fresh whole *L. wingi* colony (USNM 1482122) collected in the eastern Gulf of Alaska at a depth of 805 m.



15. *Lillipathes* sp. A

Description Colonies are large (up to 100 cm or more in height and width), rather planar, and sometimes slightly concave. They are moderately branched (up to 12 side branches off the main stem) to the fourth order or more; branches may overlap. Stem and branches have simple pinnules arranged bilaterally along the stem and branches in a variable number of rows ranging from two to six and also in alternating groups of up to three pinnules each. Pinnules are mostly 2.0–3.5 cm in length. Pinnular density (total for both rows) is 5–7 pinnules/cm where there are only two rows and 10–11 pinnules/cm where there are four rows. The distal angle of pinnules is about 60° or greater.

Spines on pinnules are simple (without lobes or bifurcations), smooth, triangular, acute or slightly rounded at the apex, slightly compressed, and project out perpendicular to the axis. Polypar spines are up to 0.08 mm in height on the thinner sections of the pinnules and up to 0.1 mm on the thicker sections. Abpolypar spines are usually about half the size of the polypar spines. Four or five rows of spines are visible in lateral view.

Polyps on pinnules are 3–4 mm in transverse diameter and the interpolypar space is very narrow. Polyp density is 2.5–3.0 polyps/cm. On the smallest branches the polyps are similar in size to those on the pinnules. As the branches increase in size the polyps become fewer and fewer until they are not visible on the stem.

Holdfasts are relatively small and irregular in shape, occasionally covered with coenenchyme, and firmly attached. The color of the coenenchyme in life is bright to light orange with reddish-orange branch axes; lighter orange to cream in ethanol.

Remarks This species differs from *L. wingi* in having a more densely branched corallum with the branches projecting at varying angles to the lower order branches from which they arise. In addition, the pinnules are shorter (2.0–3.5 cm versus up to 5.0 cm in length) and the number of rows of pinnules is quite variable, ranging from two to six. Because six or more rows of pinnules is characteristic of the genus *Parantipathes*, further study is needed, including genetic sequencing, to determine whether the genetic boundaries between *Lillipathes* and *Parantipathes* need to be redefined.

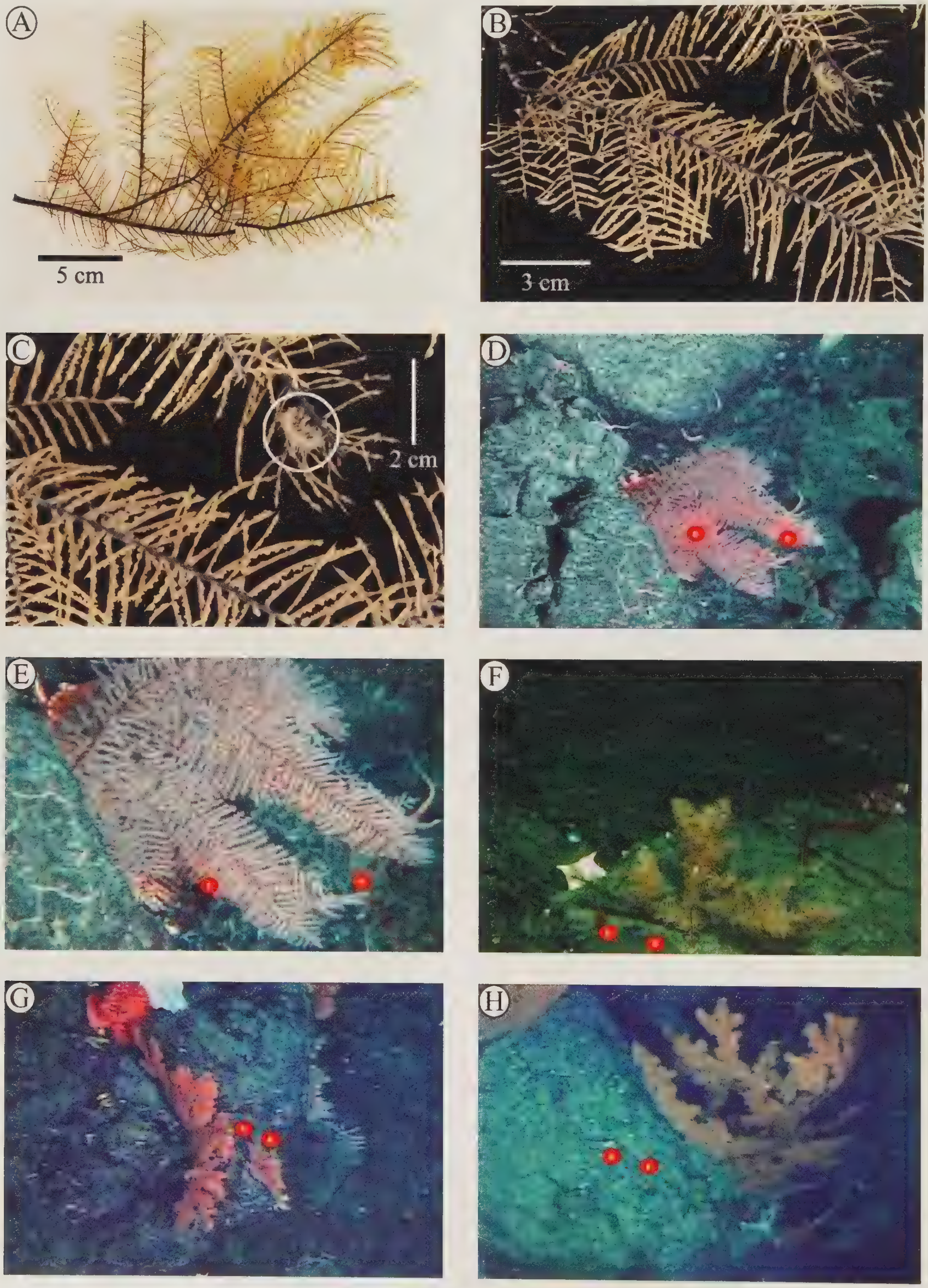
The sternostylid crab *Sternostylus iaspis* often uses large colonies as platforms for suspension feeding. Some colonies host polychaetes (see photo C on next page) and ophiuroids are often associated with larger colonies too, presumably also using them for a feeding platform.

Distribution Common and locally abundant. In Alaska – this is predominantly a seamount species. Specimens have been collected on Dickens and Murray Seamounts in the Gulf of Alaska Seamount Province and a single specimen has been collected west of Prince of Wales Island in the eastern Gulf of Alaska. Colonies have also been observed on video footage collected on Welker, Pratt, Quinn, Giacomini, Patton, Marchand, and Chirikof Seamounts (Fig. 2-14). Colonies are particularly abundant on Murray Seamount where they have been observed up to 5 colonies/m^2. Elsewhere – unknown.

Habitat Occasionally found singly but more often in patches of 10 or more colonies and typically in linear rows (colonies may overlap) along bedrock ridges, including lava flows and breccias. Also found on fractured bedrock, boulders, and cobbles. Total depth range is 600 to 2738 m.

Photos A) A *Lillipathes* sp. A specimen (USNM 1070908; preserved in ethanol) collected on Dickens Seamount at a depth of 1652 m. B) A close-up view of the same specimen in photo A. C) A close-up view of the same specimen in photo A with associated polychaete (indicated by the white circle). D) A *Lillipathes* sp. A colony (USNM 1070908) collected on Dickens Seamount at a depth of 1652 m. E) A close-up view of the same colony in photo D. The distance between the red laser marks in photos D and E is 10 cm. F) A *Lillipathes* sp. A colony observed on Quinn Seamount at a depth of 761 m. G) *Lillipathes* sp. A colonies on a bedrock ridge on Murray Seamount at a depth of 1211 m. H) *Lillipathes* sp. A colonies on a bedrock ridge on Murray Seamount at a depth of 1086 m. The distance between the red laser marks in photos F–H is 20 cm.

15. *Lillipathes* sp. A (continued)


A
5 cm
B
3 cm
C
2 cm
D
E
F
G
H

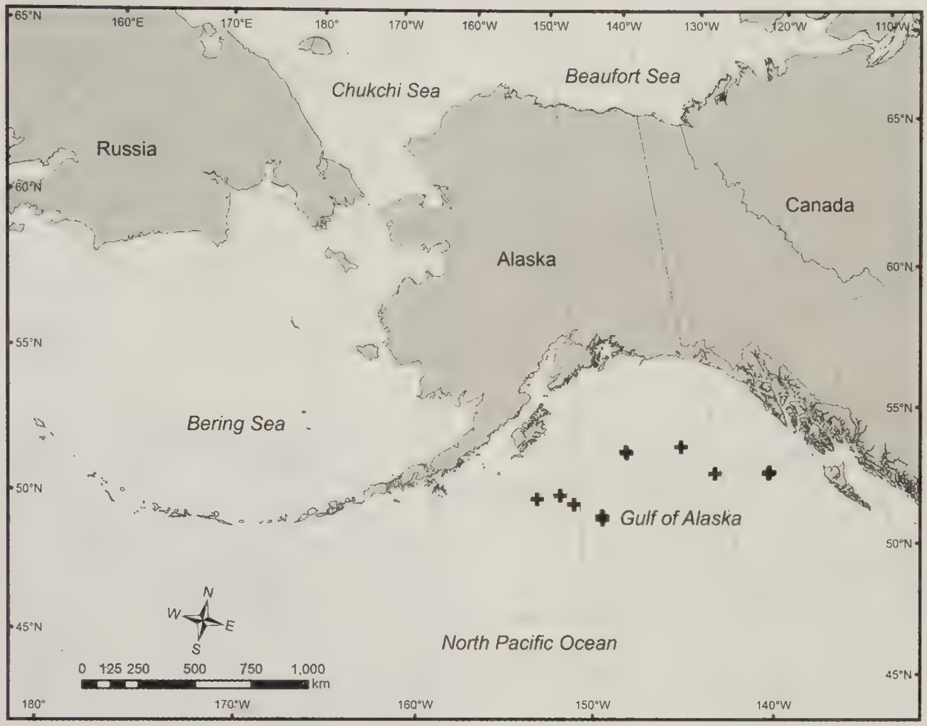

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
60°N
Canada
Alaska
55°N
Bering Sea
50°N
Gulf of Alaska
45°N
N
W
E
S
North Pacific Ocean
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W
65°N
60°N
55°N
50°N
45°N

Figure 2-14

A map of the North Pacific Ocean showing the distribution of *Lillipathes* sp. A (+) in Alaska waters.

16. *Parantipathes euantha* (Pasternak, 1958)

Description Coralla are monopodial, without branches or very sparsely branched. The stem and branches are pinnulate. The corallum measures to more than 50 cm in height and to 14 cm in width. The lower part of the stem is without branches and may be sharply curved in those colonies growing on the sides of vertically sloped substrate. Pinnules are simple, without subpinnules, and arranged in up to six rows along the length of the stem and branches (if present), and in alternating semi-spiral groups of up to three pinnules each on both sides of the axis (see Fig. 2-3H for a generic example). The lowermost pinnules on the stem may be in only two rows, increasing to four rows higher up, and then to six rows. In each group of semispiral pinnules, the anterior one is the most basal and the posterior one the most distal relative to the direction of the stem. Individual pinnules may be missing in some groups. Each semispiral group of three pinnules extends 2.25–5.00 mm along the axis, with 2.2–2.7 groups/cm and 12–14 pinnules/cm (total for all rows). Pinnules may curve toward the back (abpolypar) side of the corallum and may also extend distally (distal angle 50–80°). Pinnules in posterior rows are mostly about 4 cm in length; those in anterior rows are not more than 2.8 cm in length (Molodtsova and Pasternak, 2005). Some of the Alaska specimens have pinnules that are longer than those in the type specimen (7 cm versus 4 cm), and more densely arranged (up to 20 pinnules/cm versus 12–14 pinnules/cm).

Spines on the pinnules are simple, smooth, rounded at the apex, compressed, and triangular in lateral view. They project perpendicular to the axis, are 0.07–0.10 mm in height, arranged in longitudinal rows with five to six visible in lateral view, and within each row the spines are mostly 0.27–0.40 mm apart resulting in 3.0–3.5 spines/mm in each row (Molodtsova and Pasternak, 2005).

Polyps on the pinnules are arranged uniserially on the front, upper or lower side, mostly 1.9–2.7 mm in transverse diameter (maximum about 3 mm), and spaced 0.34–1.23 mm apart resulting in 2.5–3.3 polyps/cm (Molodtsova and Pasternak, 2005).

Holdfasts are small, typically cup-shaped and inconspicuous, occasionally covered with coenenchyme and not so strongly attached to the substrate. Color of the coenenchyme in life is medium to dark orange; light orange when preserved in ethanol.

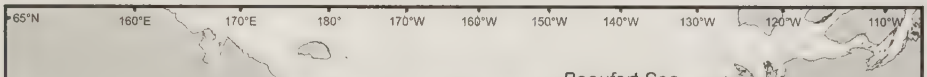


Figure 2-15

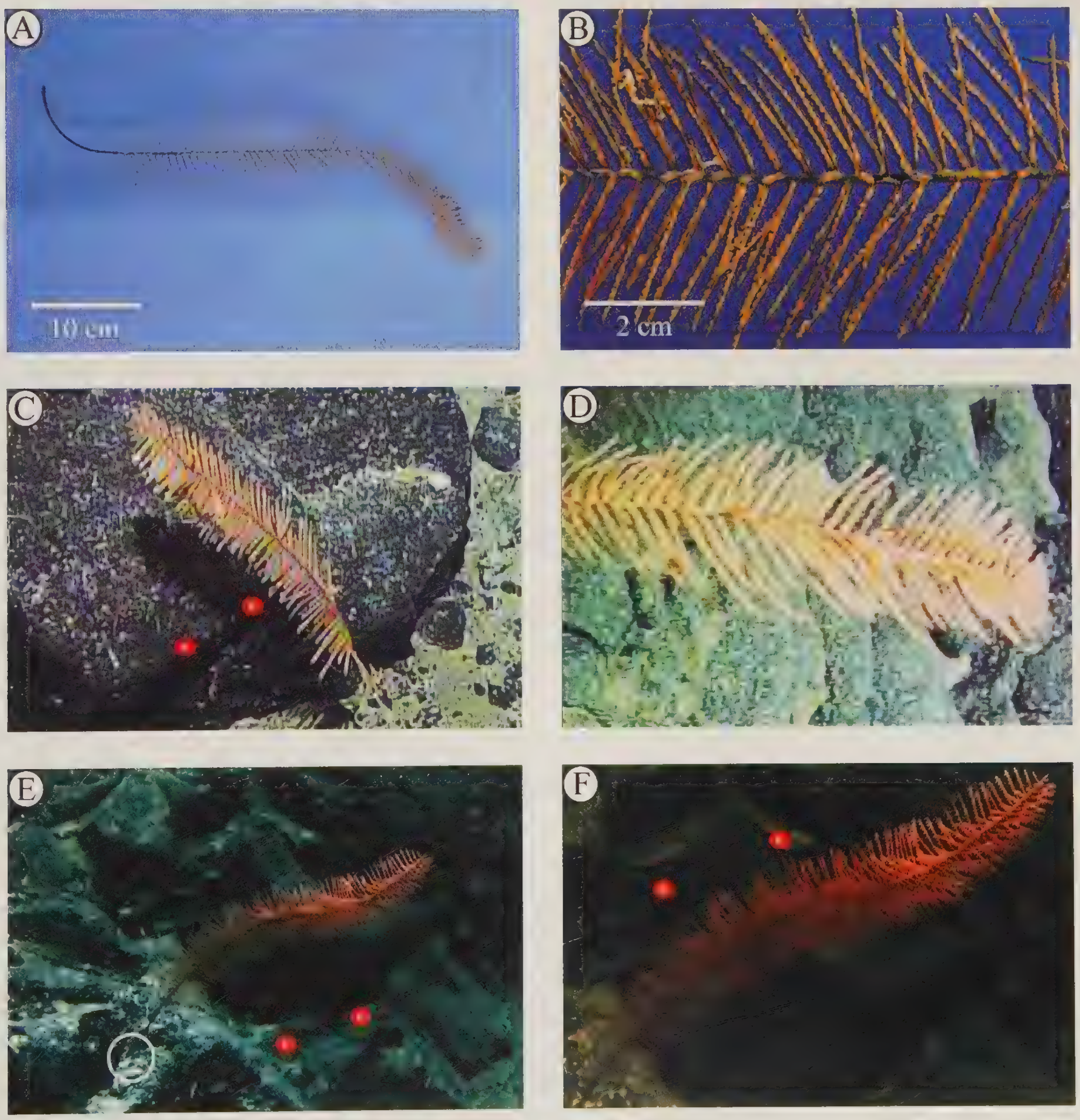
A map of the North Pacific Ocean showing the distribution of *Parantipathes euantha* (+), *P. pluma* (♦), and *Parantipathes* sp. A (▲) in Alaska waters.

Remarks This species was originally described as *Bathypathes euantha* Pasternak, 1958. *Parantipathes euantha* primarily differs from *P. pluma* in having shorter pinnules (up to 7 cm versus up to 13 cm). Ophiuroids and swarms of euphausiids are often associated with this species.

Distribution Uncommon. In Alaska – this is predominantly a seamount species having been collected on Densen, Welker, and Pratt Seamounts and additionally observed on video footage collected on Quinn Seamount. The only specimen not collected on a seamount was collected in southern Amchitka Pass in the central Aleutian Islands (Fig. 2-15). Elsewhere – not specifically reported but *Parantipathes* morphotypes, likely *P. euantha* or *P. pluma*, are reported off northern Vancouver Island (British Columbia), Juan de Fuca Ridge (Washington), and northern California.

Habitat In Alaska – typically occur singly or in low-density patches with *Narella arbuscula* Cairns and Baco, 2007 on bedrock, including basalt pillow lavas and boulders, at depths between 862 and 2762 m. Elsewhere – *Parantipathes* range in depth from 859 to 1904 m in northern British Columbia, 2283 m on Juan de Fuca Ridge, and 2820 m off northern California.

Photos A) A preserved (in ethanol) whole *P. euantha* colony (USNM 1070913) collected on Pratt Seamount at a depth of 1907 m. B) A close-up view of the same specimen in photo A. C) The same colony in photo A in situ just prior to collection. D) A *P. euantha* colony (USNM 1070631) just prior to collection on Densen Seamount at a depth of 2345 m. E) A *P. euantha* colony observed on Quinn Seamount at a depth of 2159 m. The base of the colony is indicated by the white circle. F) A close-up view of the same colony in photo E. The distance between the red laser marks in photos C, E, and F is 10 cm.



17. *Parantipathes pluma* Opresko and Molodtsova, 2021

Description (Adapted from Opresko and Molodtsova, 2021) Coralla are monopodial and typically unbranched but occasionally branched (see photo E). The largest recorded colony is up to 220 cm in height with 12 branches. Branches may develop within 10 cm of the holdfast. Stem and branches are densely pinnulate. Lower 15–20% of the main stem lacks pinnules. Pinnules are simple, without subpinnules, up to 13 cm in length, inclined distally, arranged bilaterally in varying degrees of regularity in four to six rows along the length of the stem (and branches when present), with two to three rows on each side of the axis, and in alternating semi-spiral groups of two to three (very rarely four) pinnules each (Fig. 2-3H). Pinnular density is quite variable, but the total for all rows is commonly 11–13 pinnules/cm (range 9–16 pinnules/cm).

Spines are smooth, usually simple, acute, and triangular in lateral view with the base extending out along the axis; up to about 0.09 mm in height. Spines on thinner parts of the pinnules are more rounded at the apex. Polyps on pinnules are 2.8–3.2 mm in transverse diameter, arranged uniserially, with 2.5–3.0 polyps/cm on the axis.

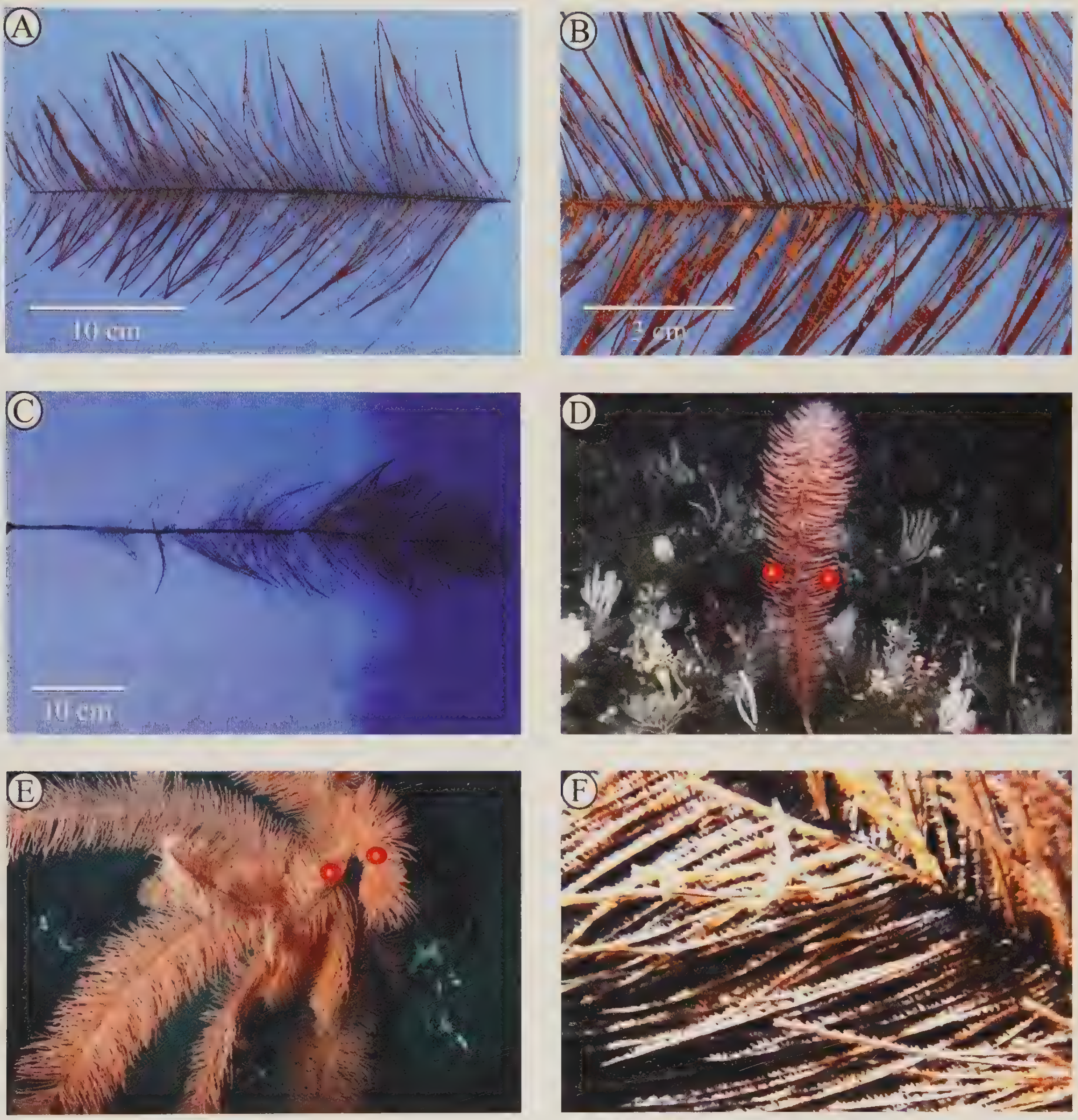
Holdfasts are large, typically circular, conspicuous in larger colonies, often covered with coenenchyme, and strongly attached to the substrate. Color of the coenenchyme in life is medium to dark orange and a duller orange when preserved in ethanol.

Remarks This species differs from *P. euantha* primarily in having longer pinnules (up to 13 cm versus up to 7 cm). Holdfasts are very strong so the colony skeleton often remains upright and in place after death. Consequently, skeletons are often incrusted with hydroids, bryozoans, actiniarians, and stoloniferous octocorals (*Clavularia* spp.) and are used as elevated perches by Verrill's king crab (*Paralomis verrilli*). Other associated fauna include ophiuroids, euphausiids, and amphipods, and large, multi-branched colonies often host snailfish (*Careproctus* sp.).

Distribution In Alaska – central Aleutian Islands (southwest of Amlia Island to Amchixtam Chaxsxii) and Zhemchug Canyon in the eastern Bering Sea (Fig. 2-15). Elsewhere – unknown (but see the comment above for *P. euantha*).

Habitat In Alaska – typically occurs on bedrock, boulders, and cobbles, singly or in patches (up to 5 colonies/10 m^2). Collected specimens range in depth from 602 to 977 m but video observations (Stone, 2014) indicate that the species ranges to depths of 1562 m in the central Aleutian Islands. Elsewhere – unknown (but see the comment above for *P. euantha*).

Photos A) The dried top half of a *P. pluma* colony (USNM 1482130) collected in Adak Canyon, central Aleutian Islands at a depth of 602 m. B) A close-up view of the same specimen in photo A. C) A dried whole *P. pluma* colony (USNM 1498742) collected in Zhemchug Canyon in the eastern Bering Sea at a depth of 977 m. D) A *P. pluma* colony photographed in the central Aleutian Islands at a depth of 1003 m. E) A multi-branched *P. pluma* colony photographed in the central Aleutian Islands at a depth of 1003 m. F) A close-up view of the branching pattern of *P. pluma*. The distance between the red laser marks in photos D and E is 10 cm.


A
10 cm
B
2 cm
C
10 cm
D
E
F

18. *Parantipathes* sp. A

Description Colonies are monopodial or sparsely branched to the first order and measure to about 20 cm in height. Simple pinnules are arranged in a bottlebrush fashion along the stem and branches in six to eight rows. Pinnules are up to about 5 cm in length and are also arranged in alternating semi-spiral groups of three to four pinnules each. Pinnular density (total for all rows) is 20–22 pinnules/cm. The distal angle of the branches and pinnules is rather wide (80–90°). Spines are short, triangular, with a wide base, and up to 0.04 mm in height. Polyps are about 3 mm in transverse diameter, with 3 polyps/cm.

Colonies have a small cup-shaped holdfast, not covered with coenenchyme, that is relatively easy to detach from the substrate. Color of the coenenchyme in life and in ethanol is light orange.

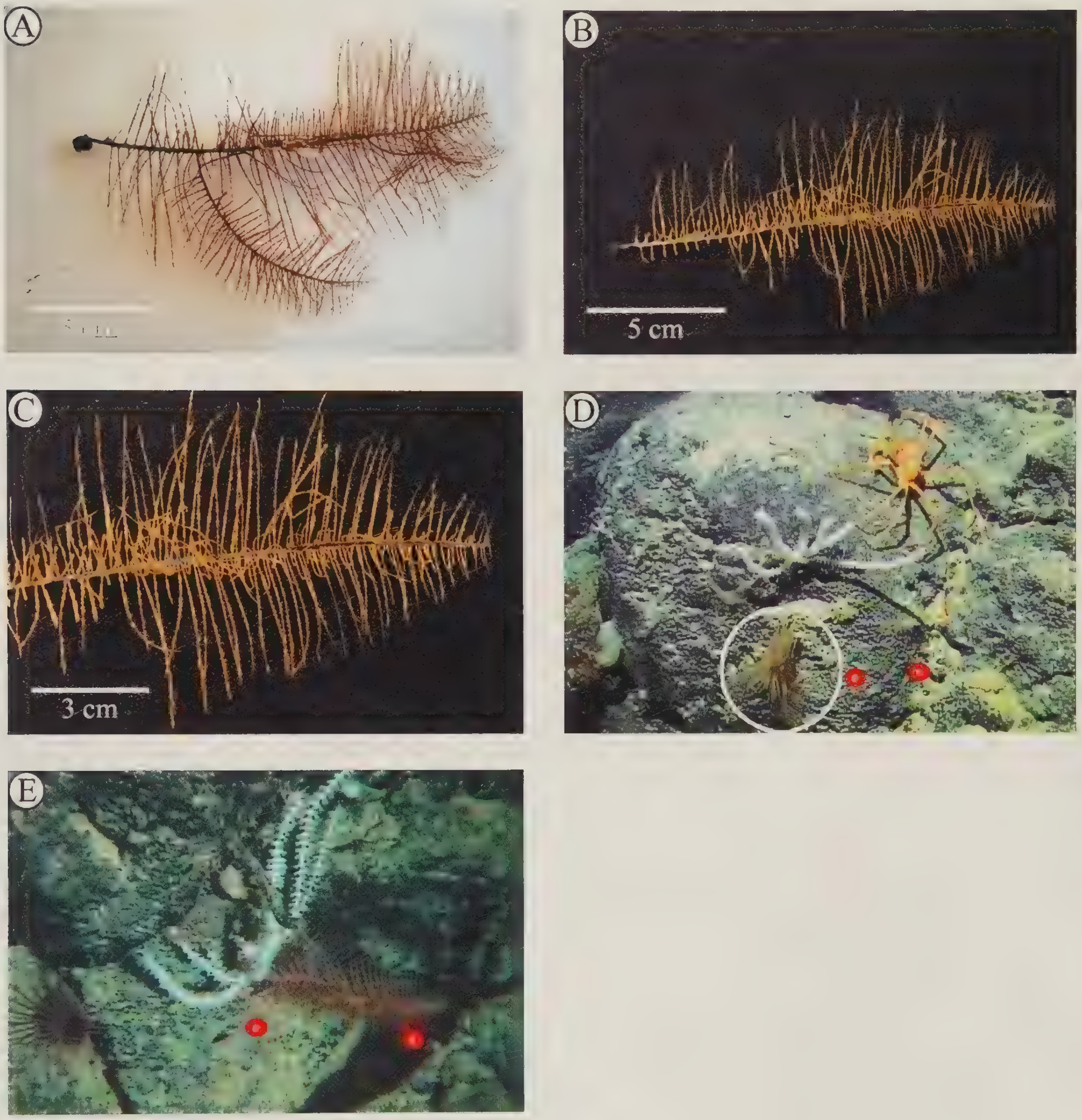
Remarks This species differs from *Parantipathes euantha* and *P. pluma* in having smaller spines, and in having pinnules in up to eight rows and in alternating groups of four, whereas in the other two species there are usually up to six rows and alternating groupings of three (although in *P. pluma* there can very rarely be a group of four pinnules). The length of pinnules is similar to that in *P. euantha* but much shorter than that in *P. pluma*.

Colonies often grow immediately next to the primnoid *Narella arbuscula* and host ophiuroid associates.

Distribution Rare. In Alaska – known only from two collected specimens and seven video observations made on Giacomini Seamount in the Gulf of Alaska Seamount Province (Fig. 2-15). Colonies occur singly or two within close proximity. Elsewhere – unknown.

Habitat Grows on bedrock (basalt) and fractured bedrock (including boulders and cobbles) at depths between 2715 and 2819 m. This is the deepest occurring species of *Parantipathes* in Alaska waters.

Photos A) A preserved (in ethanol) whole *Parantipathes* sp. A colony (USNM 1070915) collected on Giacomini Seamount at a depth of 2813 m. B) A preserved (in ethanol) whole *Parantipathes* sp. A colony (USNM 1070914) collected on Giacomini Seamount at a depth of 2819 m. C) A close-up view of the same specimen in photo B. D) A *Parantipathes* sp. A colony (USNM 1070914; indicated by the white circle) just before collection at a depth of 2813 m. Next to the specimen is a colony of *N. arbuscula* and a large-clawed crab (*Macroregonia macrochira*). E) A *Parantipathes* sp. A colony (USNM 1070915) just before collection at a depth of 2819 m with a *N. arbuscula* colony. The distance between the red laser marks in photos D and E is 10 cm.


A
B
5 cm
C
3 cm
D
E

Order Scleractinia

Corals in the order Scleractinia are known as "stony corals," but they are also sometimes referred to as "true corals." Because almost all species known from polar latitudes (including all in Alaska) and those from deep water are non-colonial and cup-shaped, they are colloquially referred to by coral biologists as "solitary corals" or "cup corals." All are ahermatypic, that is, they do not construct reefs like their colonial, tropical counterparts. Ten species of scleractinians from five families are known from Alaska waters. The current state of taxonomy for the group is excellent. All specimens collected in Alaska should be properly preserved for taxonomic examination and zoogeographic study.

Conventional terminology is used to describe the scleractinian corallum, including basic morphological features (Fig. 3-1) and septal insertion patterns (Fig. 3-2). Diagnostic features most important for taxonomic resolution include 1) the characteristics of the corallum, theca, and columella, and 2) the arrangement of septa and pali within the calice. An illustrated key and glossary of morphological terms to the 120 genera of extant azooxanthellate scleractinians are provided by Cairns and Kitahara (2012).

The polyp morphology of scleractinians is nearly identical to that of the actiniarians, or true sea anemones, except they lack ciliated lobes on the mesenterial filaments. Polyps are fully retractile. Oral tentacles are conical and arranged hexamerally, reflecting the symmetry of the septa; one tentacle is associated with each septum. The skeleton (corallum) is typically conical or discoidal and composed entirely of aragonite except for *Caryophyllia* (*Caryophyllia*) *alaskensis* Vaughan, 1941 and *C.* (*C.*) *arnoldi* Vaughan, 1900, which contain small amounts of low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

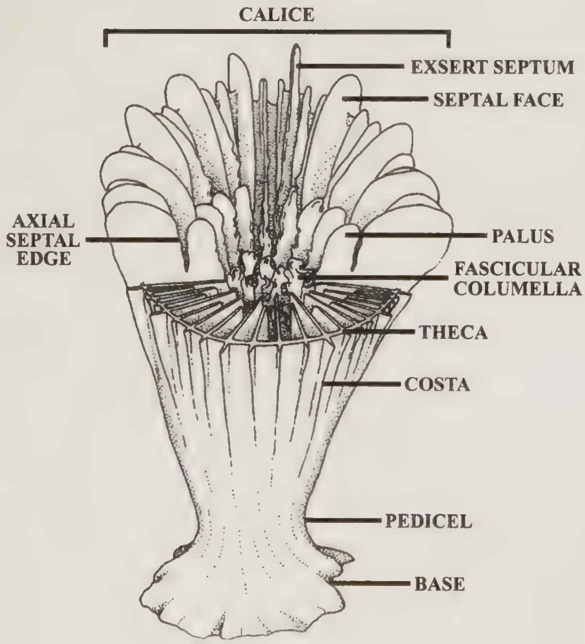


Figure 3-1

A cutaway diagram of a species of *Caryophyllia* illustrating the basic morphological features of an attached, solitary scleractinian (reproduced after Cairns, 1981 and Cairns, 1994).

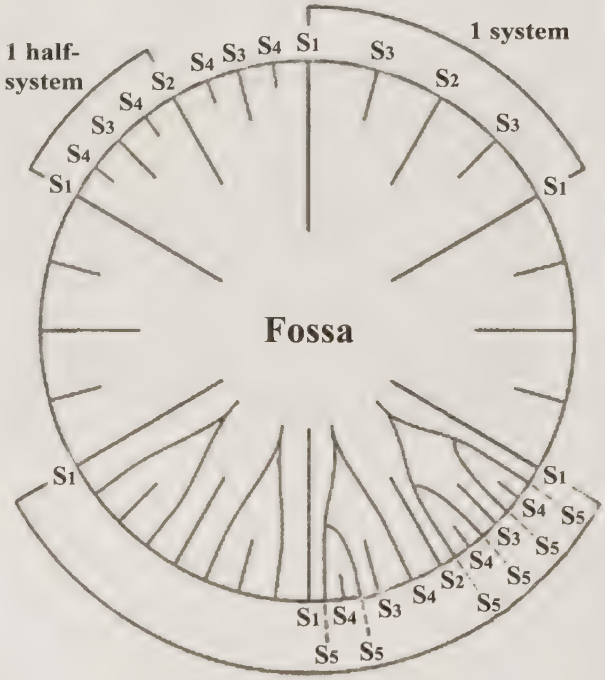


Figure 3-2

A composite cross-sectional diagram of a calice, illustrating various septal insertion patterns: upper right system with three cycles of septa, upper left system with four cycles, and lower two systems with various stages of development of the Pourtalès Plan (after Cairns, 1994). The numbers refer to the cycle to which septa belong.

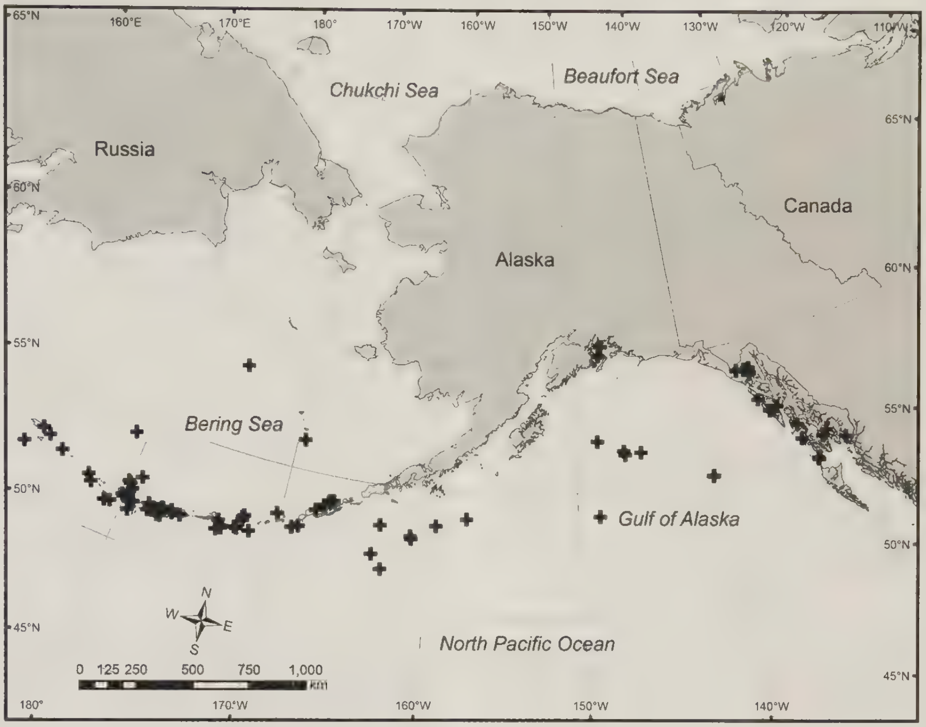

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 3-3

A map of the North Pacific Ocean showing the distribution of corals in the order Scleractinia (+) in Alaska waters.

Scleractinians are found in all regions of Alaska except the Arctic (Fig. 3-3), and records for most taxa represent the northernmost in the world, perhaps most notably for the otherwise cosmopolitan cockscomb cup coral (*Desmophyllum dianthus*) (Esper, 1794). They are an extremely eurybathic fauna in Alaska, occupying depths between 17 and 6328 m. The eight taxa found in waters shallower than 2000 m are firmly attached or fixed and typically grow on rock but are often found on siltstone, particularly on the continental shelf and upper slope of the eastern Gulf of Alaska. Two taxa found in very deep water, *Fungiacyathus (Bathyactis) marenzelleri* (Vaughan, 1906) and *Leptopenus discus* Moseley, 1880, are free-living; that is they are not attached to solid substrate but rather are settled into unconsolidated sediment. This mode is likely an adaptation to the paucity of hard substrate at the great depths (2370–6328 m) they occupy in Alaska.

Most taxa are quite small, generally only a few centimeters in diameter even when polyps are fully extended. Exceptionally large specimens of *Javania borealis* Cairns, 1994 may reach 10 cm in height, with polyps fully extended. Most taxa are found either singly or in low-density patches but at least one species, C. (C.) *alaskensis*, occasionally forms high density patches (278 corals/m^2; Stone, 2014). These patches may provide important refuge and foraging habitat for juvenile fish and crabs. They are an uncommon bycatch item in longline fisheries and stock assessment surveys and are most typically dislodged whole at the holdfast.

Family Caryophylliidae

1. *Caryophyllia* (*Caryophyllia*) *alaskensis* Vaughan, 1941

Description The skeleton is solitary, ceratoid, and always attached by a slender pedicel. The calice is circular to elliptical; the calicular edge is finely serrate. Most specimens are less than 20 mm in height and 21 mm in greater calicular diameter, but exceptional specimens measure up to 27 mm in height and 34 mm in calicular diameter. The theca is smooth (porcelaneous) and milky white; the polyp is typically orange.

Septa are hexamerally arranged in at least four complete cycles (48 septa, 12 pali), but larger specimens may have up to five complete cycles of septa (96 septa, 24 pali), with all variations between. The septal formula is S1–2>S3>S4>S5. Septa S1–2 are only slightly exsert (less than 1 mm); pali have very sinuous axial edges. The fossa is shallow, containing a fascicular columella of 5–15 slender twisted laths.

Remarks *Caryophyllia* (*Caryophyllia*) *alaskensis* is very similar to *C.* (*C.*) *arnoldi* (see next species description), but *C.* (*C.*) *alaskensis* has a more northern distribution, the two species overlapping off British Columbia and the Gulf of Alaska (Cairns, 1994). It is one of the more common scleractinians collected in Alaska waters. The 66 Recent species of *Caryophyllia* are keyed in Kitahara et al. (2010).

Distribution Widespread and locally common. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, the Aleutian Islands (north of Unalaska Island to east of Attu Island) including Petrel Bank and Bowers Ridge, and the eastern Bering Sea continental slope (Fig. 3-4). Elsewhere – southeast to the Strait of Georgia, British Columbia, and southwest to the Commander Islands (Russia) and Sea of Japan (Republic of South Korea).

Habitat In Alaska – typically found in patches, sometimes quite dense (278 corals/m^2; Stone, 2014), on hard rock in areas of moderate current and at depths between 90 and 1397 m. Elsewhere – depths between 103 and 223 m.

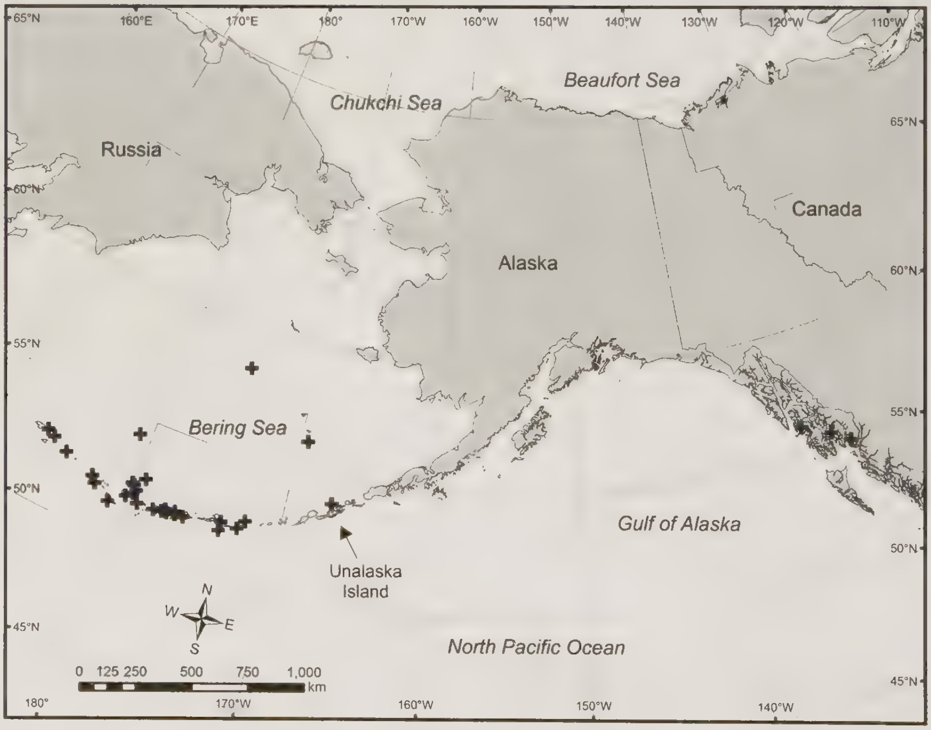
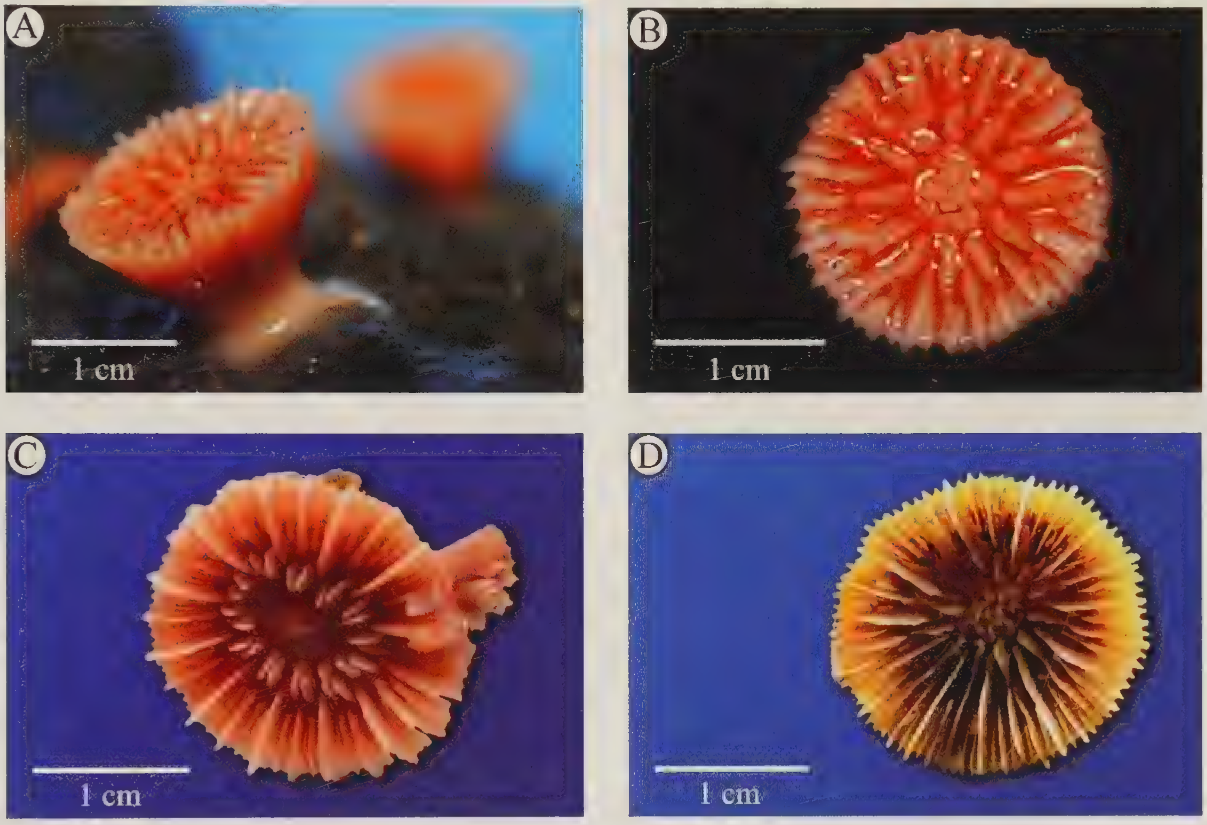

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
Unalaska Island
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 3-4

A map of the North Pacific Ocean showing the distribution of *Caryophyllia alaskensis* (+) in Alaska waters.

Photos A) A fresh C. (C.) *alaskensis* specimen (USNM 1116848) collected in Zhemchug Canyon, eastern Bering Sea, at a depth of 909 m. B) A view from the top of the same specimen in photo A. C) A C. (C.) *alaskensis* specimen collected near Bobrof Island, central Aleutian Islands, at a depth of 119 m. D) A calicular view of a dried C. (C.) *alaskensis* specimen (USNM 99373) collected near the Semichi Islands, western Aleutian Islands, at a depth of 95 m.



2. *Caryophyllia (Caryophyllia) arnoldi* Vaughan, 1900

Description The skeleton is solitary, robust, ceratoid to trochoid, and always firmly attached by a thick pedicel. The calice is circular to elliptical; the calicular edge is finely serrate. The largest known specimen is 17 mm in height and 16 mm in greater calicular diameter. The theca is white, bearing granular costae, whereas the polyp is typically light orange to orange.

Septa are hexamerally arranged in four complete cycles (48 septa, 12 pali) with a septal formula of S1–2>S3>S4. Septa S1–2 are moderately exsert (over 1 mm); pali have extremely sinuous axial edges. The fossa is shallow, containing a fascicular columella of 5–25 twisted laths, occasionally fused into a massive structure.

Remarks As reported by Cairns (1994), *Caryophyllia (Caryophyllia) arnoldi* is similar to *C. (C.) alaskensis* but differs in having a more robust, denser skeleton with a thicker pedicel; having granular costae (not smooth theca); never having more than 48 septa; having more exsert septa; and having wider S4, almost as wide as their S3.

Distribution Widespread and locally common. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, the western Gulf of Alaska (Prince William Sound), the Gulf of Alaska Seamount Province (Giacomini Seamount), and northwest of Unalaska Island to Amchixtam Chaxsxii in the Aleutian Islands (Fig. 3-5). Elsewhere – distributed south to Queen Charlotte Islands (British Columbia), Strait of Juan de Fuca (Washington), Cordell Bank to off San Diego (California) and the Galapagos Islands (Ecuador).

Habitat In Alaska – typically found in patches on hard rock, including cobbles, in areas of moderate current and at depths between 21 and 1702 m. Elsewhere – depths between 75 and 657 m. Co-occurs in dense mats with the zoantharian *Mesozoanthus* sp. in Prince William Sound.

Photos A) A fresh *C. (C.) arnoldi* specimen (USNM 1407047) collected in the West Arm of Glacier Bay, Southeast Alaska at a depth of 292 m. B) A side view of the same specimen in photo A. C) The same specimen in photo A, dried. D) Two *C. (C.) arnoldi*, tentacles fully extended, photographed on bedrock in the central Aleutian Islands at a depth of 862 m.

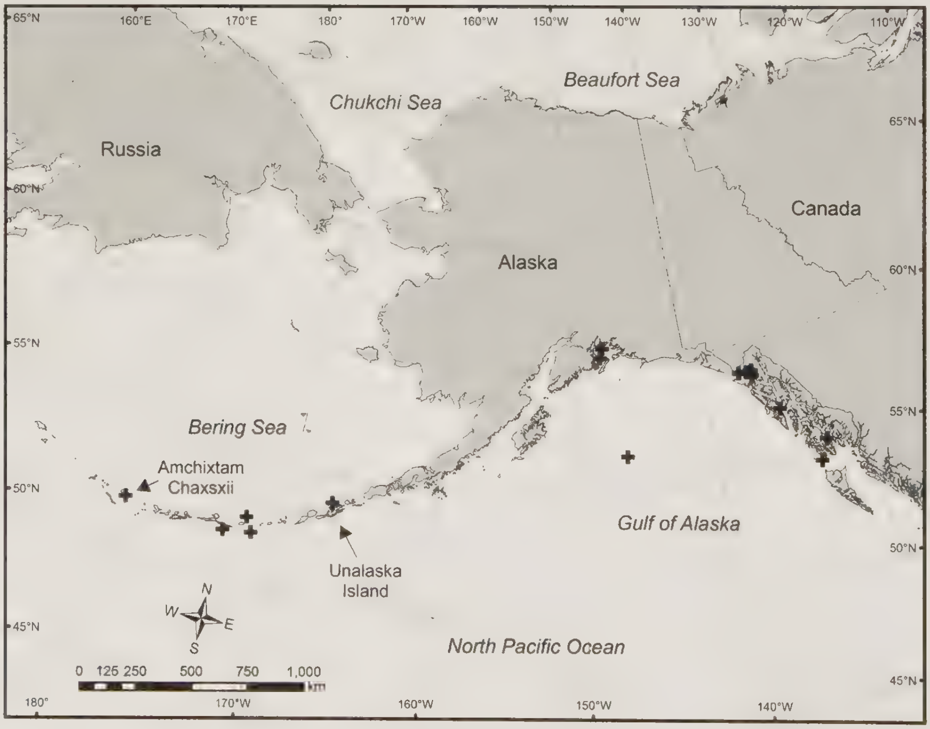
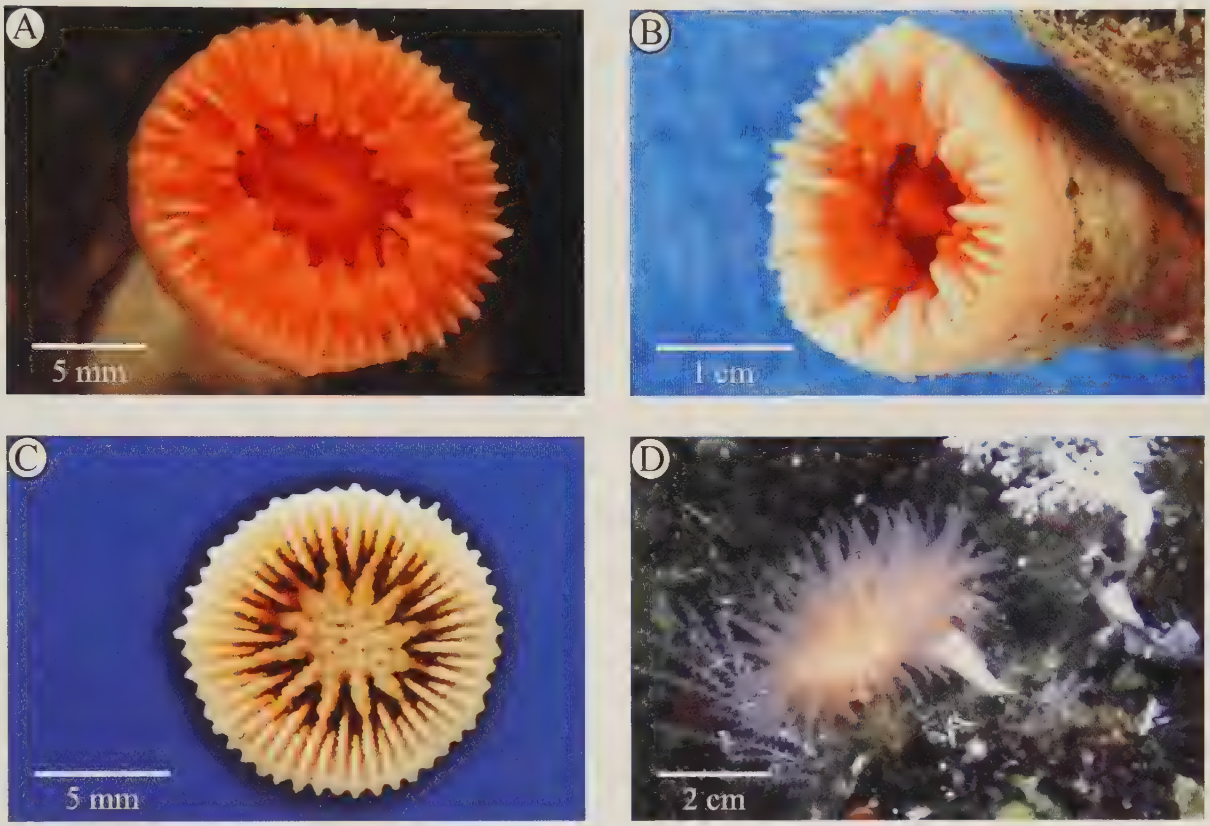

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
Amchixtam
Chaxsxii
50°N
Gulf of Alaska
50°N
Unalaska
Island
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 3-5

A map of the North Pacific Ocean showing the distribution of *Caryophyllia arnoldi* (+) in Alaska waters.


A
5 mm
B
1 cm
C
5 mm
D
2 cm

3. *Crispatotrochus foxi* (Durham and Barnard, 1952)

Description The skeleton is solitary, trochoid, and always firmly attached by a robust pedicel. The calice is circular to slightly irregular in shape. Most specimens are less than 19 mm in height and 15 mm in greater calicular diameter. Granular costae are slightly ridged in the upper half to third of skeleton. The corallum is white; the polyp is orange to pale orange.

Septa are hexamerally arranged in five complete cycles (96 septa) with a septal formula of S1–2>S3>>S4>S5. Septa S1–2 are only slightly exsert and have straight axial edges. Pali are absent. The fossa is moderately deep, containing a small fascicular columella consisting of 4–7 broad, twisted laths that are usually laterally fused to one another.

Remarks This species can be distinguished from all other Alaska scleractinians by having fascicular columella and lacking pali; it is otherwise similar to *Caryophyllia* except for its lack of pali. It is rarely collected, so if encountered should be properly preserved and sent to a museum, such as the National Museum of Natural History (Smithsonian Institution), for verification and archival.

Distribution Rare. In Alaska – known from only four specimens collected at three locations between Umnak Island and northern Amchitka Pass in the Aleutian Islands (Fig. 3-6). One of the four specimens could be confirmed only to genus but is very likely *Crispatotrochus foxi* (Fig. 3-6). Elsewhere – known only from the type locality off San Miguel Island, Channel Islands, southern California.

Habitat In Alaska – typically found on cobbles at depths between 135 and 199 m except one specimen (the one confirmed only to genus) at a depth of 702 m. Found in association with the scleractinians *Caryophyllia* (*Caryophyllia*) *alaskensis* and *Javania* spp. Elsewhere – 82 m depth.

Photos A) A calicular view of a dried *C. foxi* specimen (USNM 19210) collected in the eastern Aleutian Islands at a depth of 199 m. B) Fresh *C. foxi* specimens (USNM 1482090) collected in the eastern Aleutian Islands at a depth of 135 m.

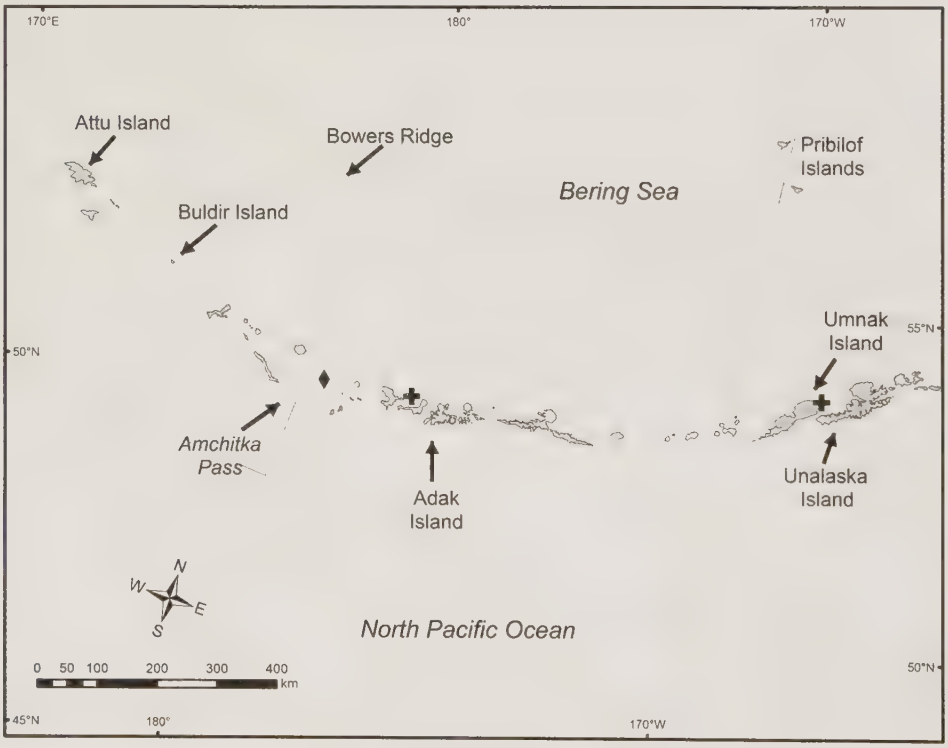
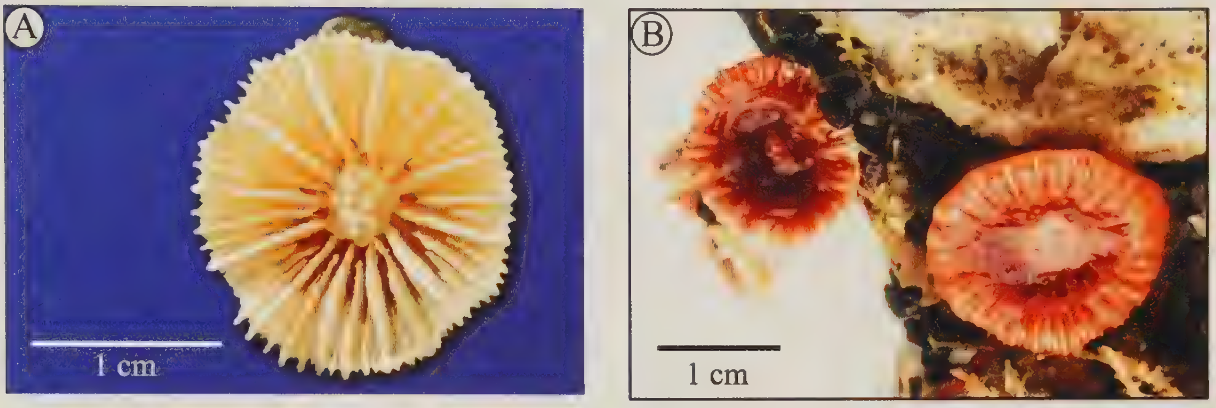


Figure 3-6

A map of the North Pacific Ocean showing the distribution of *Crispatotrochus foxi* (+) in Alaska waters. One specimen (♦) could be confirmed only to the genus.


A
1 cm
B
1 cm

4. *Desmophyllum dianthus* (Esper, 1794)

Description The skeleton is solitary, ceratoid, often with a flared calice (trumpet-shaped), and always attached by a robust pedicel. The calice is circular, slightly elliptical, or even scalloped (if large). The Alaska specimen measures up to 5 cm in height and 4×6 cm in calicular diameter, although larger specimens are known from New Zealand fjords. The theca is granular and the C1–3 are usually slightly ridged in the upper half of the skeleton. The corallum is white, light brown or grey; the polyps are light orange.

Septa are hexamerally arranged in up to six cycles (192 septa), according to the formula S1–2>S3>>S4>S5>S6; septa S6 are complete only in the largest of specimens. Septa S1–2 are often highly exsert, up to 10 mm, and have straight axial edges. Pali are absent. The fossa is deep and slender, usually lacks a columella, but may have a rudimentary papillose element that is usually hidden from view in an intact corallum.

Remarks Morphologically, *Desmophyllum dianthus* is unique and perhaps the simplest of the scleractinian corals in having the combination of being solitary (not colonial), lacking pali, columella, and any other unique features. Its simplicity may explain why it is one of the most common and widespread living scleractinians, and one of only a dozen species worldwide that is truly cosmopolitan in distribution. Even though solitary, it is considered to be a framework-forming species (Roberts et al., 2009).

Distribution Rare. In Alaska – known from only a single specimen (representing the northernmost in the world) collected north of Dixon Entrance, eastern Gulf of Alaska near the border with British Columbia (Fig. 3-7). Elsewhere – widespread, cosmopolitan (found in all world oceans).

Habitat In Alaska – the single specimen was collected at a depth of 398 m and was attached to the heavily calcified base of a large red tree coral (*Primnoa pacifica* Kinoshita, 1907). Elsewhere – extremely eurybathic. Considered a deep-sea emerged species in southern Chilean fjords (to 8 m depth; Försterra and Häussermann, 2003) and Milford Sound, New Zealand (to 25 m depth; NMNH 94068 and 94072), but found to depths as great as 2200 m on the Charleston Bump off the southeastern Atlantic Coast of the U.S.

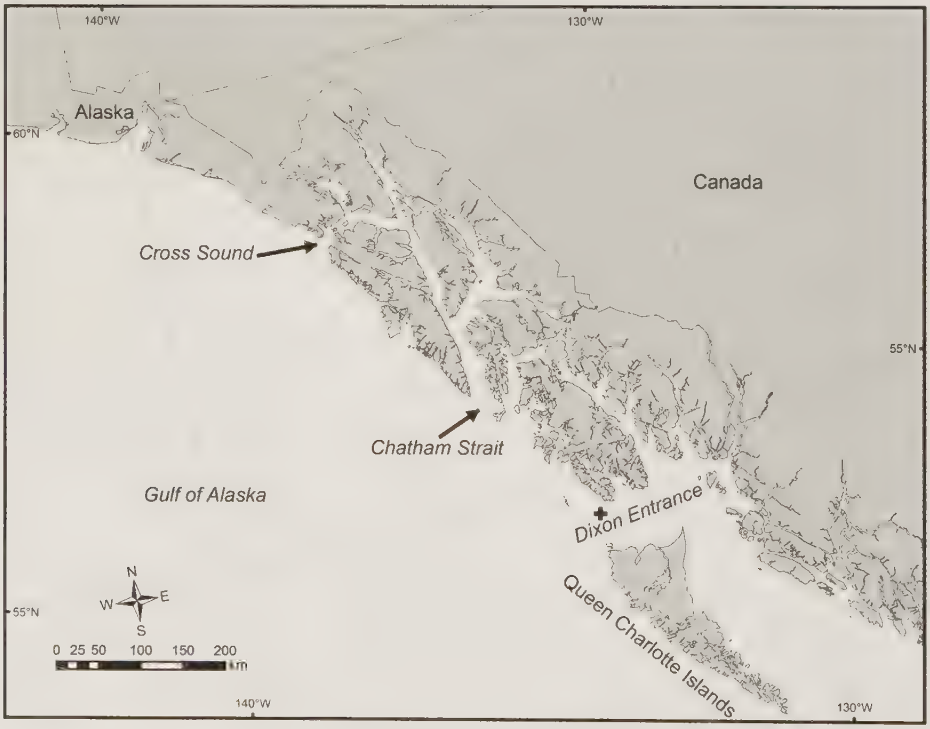
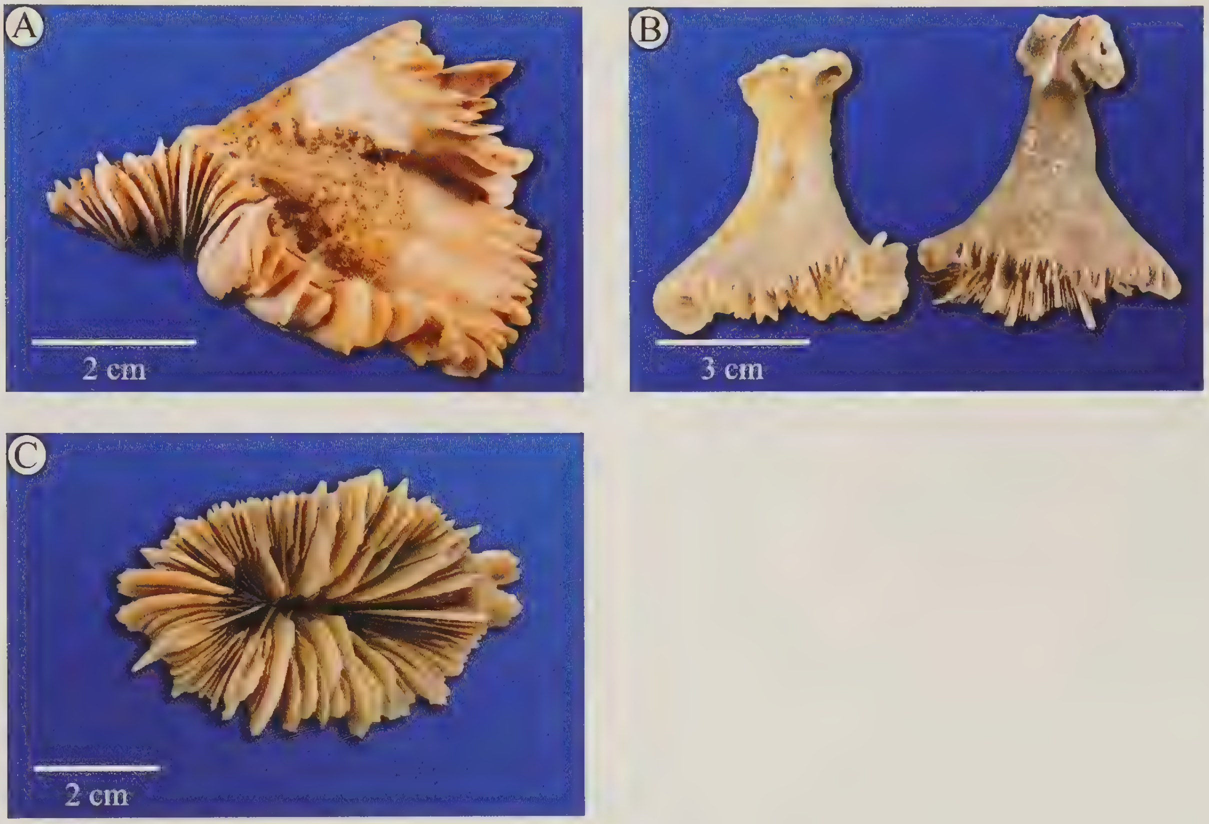


Figure 3-7

A map of the eastern Gulf of Alaska showing the distribution of *Desmophyllum dianthus* (+) in Alaska waters.

Photos A) A large dried fragment of *D. dianthus* (USNM 1482091) collected in the eastern Gulf of Alaska at a depth of 398 m. The specimen is partially encrusted with the demosponge *Poecillastra tenuilaminaris*. B) A lateral view of two dried *D. dianthus* specimens (USNM 36545) collected off the coast of Chile at a depth of 821 m. C) A calicular view of the same specimen in photo B.



Family Dendrophylliidae

5. *Balanophyllia (Balanophyllia) elegans* Verrill, 1864

Description The skeleton is solitary, cylindrical to trochoid in shape (often short and squat), with a thick attached pedicel and polycyclic base. Large specimens are up to 18 mm in height and 17 mm in greater calicular diameter. The theca is vermiculate (spongy, porous) and rough to the touch (called a synapticulotheca), but on the lower third to half of the corallum, the synapticulotheca is covered by a smooth thin epitheca, on which encrusting organisms are often attached. The skeleton is white, but shallow-water (<30 m) specimens are often encrusted with purple coralline algae (*Lithothamnion* spp.; see photo D); polyps are bright orange or reddish-orange.

The septa are distinctively arranged in a stellate pattern (the Pourtalès Plan) in four to five cycles; the last cycle is never complete, resulting in 48–88 septa. Axial edges of S1–2 are smooth, but those of higher cycle septa are laciniate. Pali are absent. The fossa is of moderate depth, containing an elongate, spongy columella that fuses to the axial edges of many of the septa.

Remarks Among the Scleractinia known from Alaska waters, *Balanophyllia (Balanophyllia) elegans* is unique in being the only dendrophylliid in the region, and thus the only species to have a porous skeleton and septa arranged in a Pourtalès Plan. Although quite common off the west coast of the continental United States and Canada, it is quite rare in Alaska waters but found in small patches where present.

Distribution Rare. In Alaska – known from only two specimens (representing the northernmost in the world) collected at two locations in the eastern Gulf of Alaska (Fig. 3-8) but also known from photographs collected during shallow-water resource surveys (see photos D–F). Elsewhere – Vancouver Island, British Columbia, to southern California.

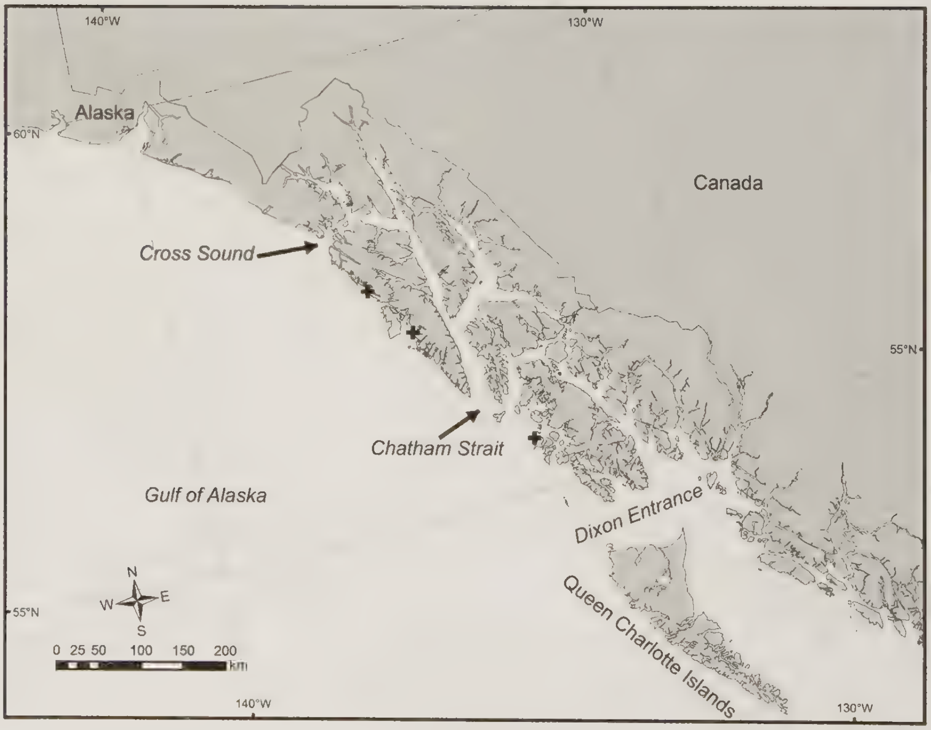
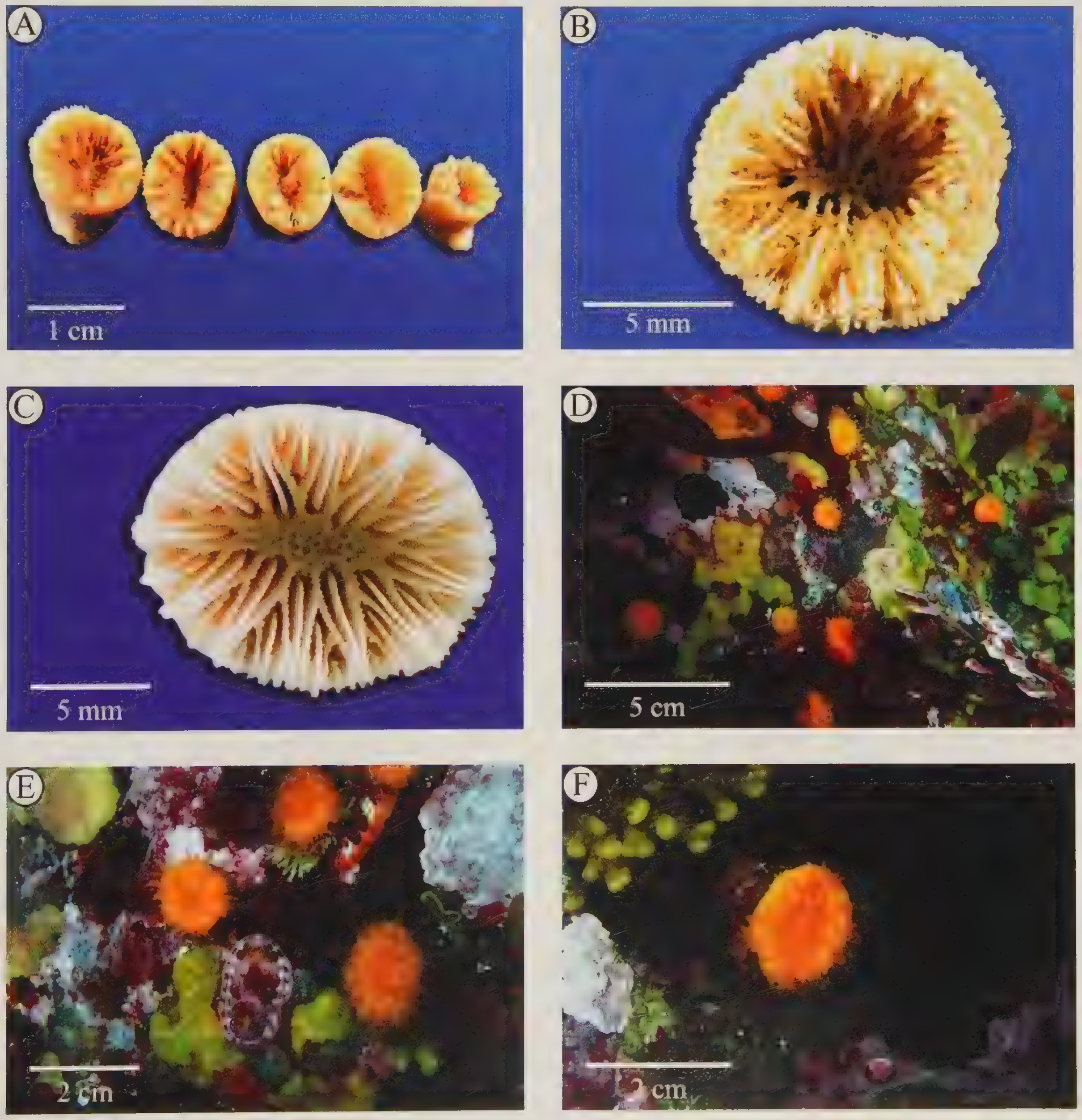


Figure 3-8

A map of the North Pacific Ocean showing the distribution of *Balanophyllia (Balanophyllia) elegans* (+) in Alaska waters.

Habitat In Alaska – specimens have been collected at 22 m depth but observed as shallow as 15 m (Harris[3]). Grows on bedrock and boulders in areas of moderate to strong current. Elsewhere – grows on bedrock, boulders, cobbles, and pebbles from tide pools to depths of 177 m. Durham (1947) lists the depth range to 296 m but provides no documentation for the record.

Photos A) Five dried *B.* (*B.*) *elegans* specimens (USNM 1482079) collected in the eastern Gulf of Alaska at a depth of 22 m. B) A calicular view of a dried *B.* (*B.*) *elegans* specimen (USNM 1482079) collected in the eastern Gulf of Alaska at a depth of 22 m. C) A calicular view of a dried *B.* (*B.*) *elegans* specimen (USNM 92623) collected north of the Farallon Islands, California at a depth of 53 m. D) A small patch of *Balanophyllia* (*B.*) *elegans* photographed near Cape Ulitka, Noyes Island in the eastern Gulf of Alaska at a depth of about 15 m. E) A close-up view of several corals in the same patch (with tentacles fully extended). F) A close-up view of a coral in the same patch (with tentacles retracting). Photos D–F are courtesy of D. K. Harris, Alaska Department of Fish and Game.



---

[3] Harris, D. K. 2018. Personal observ. Alaska Dep. Fish Game, Juneau, AK 99801.

Family Flabellidae

6. *Flabellum* (*Flabellum*) *oclairi* Cairns, sp. nov.

Synonymy

Flabellum (*F.*) sp. A Cairns, 1994:28–29, plates 10a–b.

Flabellum impensum Cairns, 1995:100.

Flabellum sp. Stone and Shotwell, 2007:105 (listed).—Stone and Cairns, 2017:3 (listed).

Material examined Holotype: Station 69RD3, National Museum of Canada (Canadian Museum of Nature), Invertebrate Collection, Ottawa, 1982-1492. Paratypes: ex AB02-0123B, scuba collection, central Aleutian Islands, 51°52.20′N, 179°49.85′W, 27 m depth, 17 July 2002, four specimens, USNM 1011163; RV *Vesteraalen*, haul station 5, eastern Aleutian Islands, 52°40.76′N, 169°06.61′W, 110 m depth, 21 May 2001, six specimens, USNM 1010473; RV *Alaskan Leader*, haul station 35, eastern Aleutian Islands, 53°04.55′N, 170°13.88′W, 407 m depth, 4 June 2002, one specimen, USNM 1011169; RV *Dominator*, haul station 4, eastern Aleutian Islands, 52°47.01′N, 168°41.98′W, 109 m depth, 23 May 1996, six specimens, USNM 98509; RV *Dominator*, haul station 218, western Aleutian Islands, 52°05.32′N, 172°42.99′E, 113 m depth, 4 August 1997, eight specimens, USNM 99369.

Type locality Station 69RD3: 51°25.50′N, 179°15.20′E (Kirilof Bay, northern Amchitka Island), 30 m depth, 9 October 1969.

Description The skeleton is solitary, ceratoid to trochoid, and always attached by a thick pedicel (3.6–4.1 mm in diameter) that broadens to a slightly larger scalloped basal plate up to 5.5 mm in diameter; the basal plate contains 12 protosepta. The calice is slightly elliptical, with a greater calicular diameter (GCD) to lesser calicular diameter (LCD) of about 1.2. The largest specimen is 38.5 mm in height and 26×22 mm in calicular diameter. The theca is milky white and porcelaneous; the polyps are bright orange.

The septa are hexamerally arranged in five complete cycles in larger specimens with a formula of S1–2>S3>>S4>S5 (S5 rudimentary). The fourth cycle of 48 septa is attained at a GCD of about 11 mm and the fifth at a GCD of about 17 mm. The septa are not exsert, thin and quite fragile, having straight axial edges. Pali are absent; the fossa is deep; a columella is absent.

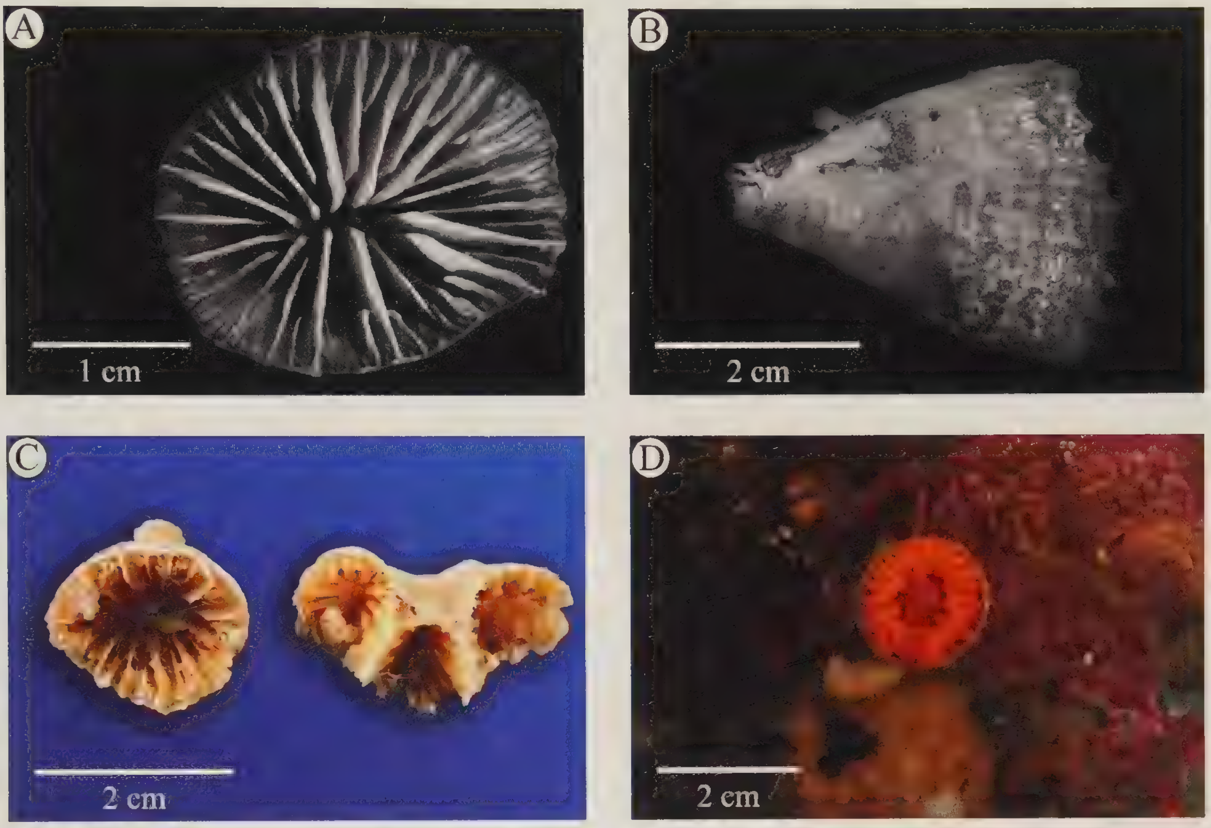
Remarks Cairns (1994, 1995) suggested that this species was very similar to the ceratoid form of the Antarctic species *Flabellum* (*F.*) *impensum* Squires, 1962, even though that would have postulated a broadly disjunct distribution pattern. *Flabellum* (*F.*) *impensum* is reported from only the Southern Hemisphere, principally in Antarctic seas, but also occurs in the South Atlantic (Scotia Sea, Drake Passage, and off the coast of Argentina) and South Pacific (New Zealand) at depths of 46–2260 m (Cairns, 1982, 1994, 1995). Now that additional specimens are available for examination, it appears that the Alaska specimens are indeed very similar but morphologically distinct from *F.* (*F.*) *impensum*, and thus represent an undescribed species. It differs in 1) having a more circular calice—GCD:LCD about 1.2 versus up to 2.8 in *F.* (*F.*) *impensum*, 2) achieving a full complement of S5 at an earlier size (17 mm GCD versus 19 mm GCD), and 3) having straight axial edges of the larger septa—those of *F.* (*F.*) *impensum* are sinuous. Also, *F.* (*F.*) *impensum* achieves a much larger size (128 mm GCD) and eventually inserts a full sixth cycle of septa (Cairns, 1982). Although these differences are minor, they do appear to be consistent.

Distribution Uncommon. In Alaska – throughout the Aleutian Islands from Unalaska Island to south of Attu Island (Fig. 3-9). Elsewhere – not reported.

Habitat Grows on bedrock and other hard substrates at depths between 27 and 507 m, although most records are shallower than 100 m. Occasionally 3–4 corals may be fused together along their thecal edges (see photo C).

Etymology Named in honor of Dr. Charles (Chuck) O'Clair, renowned marine biologist and naturalist of Alaska and the Pacific Northwest, who so carefully saved the holotype he collected near Amchitka Island in the Aleutian Islands in 1969.

Photos A) A calicular view of the *F.* (*F.*) *oclairi* sp. nov. holotype (NMCIC 1982-1492; dried) collected near Amchitka Island in the western Aleutian Islands at a depth of 30 m. B) A lateral view of the *F.* (*F.*) *oclairi* sp. nov. holotype. C) A calicular view of *F.* (*F.*) *oclairi* sp. nov. paratypes (USNM 1011163; dried) collected near Semisopochnoi Island, central Aleutian Islands, at a depth of 27 m. D) *Flabellum* (*F.*) *oclairi* sp. nov. (at left in photo C) photographed immediately after collection.


A
1 cm
B
2 cm
C
2 cm
D
2 cm

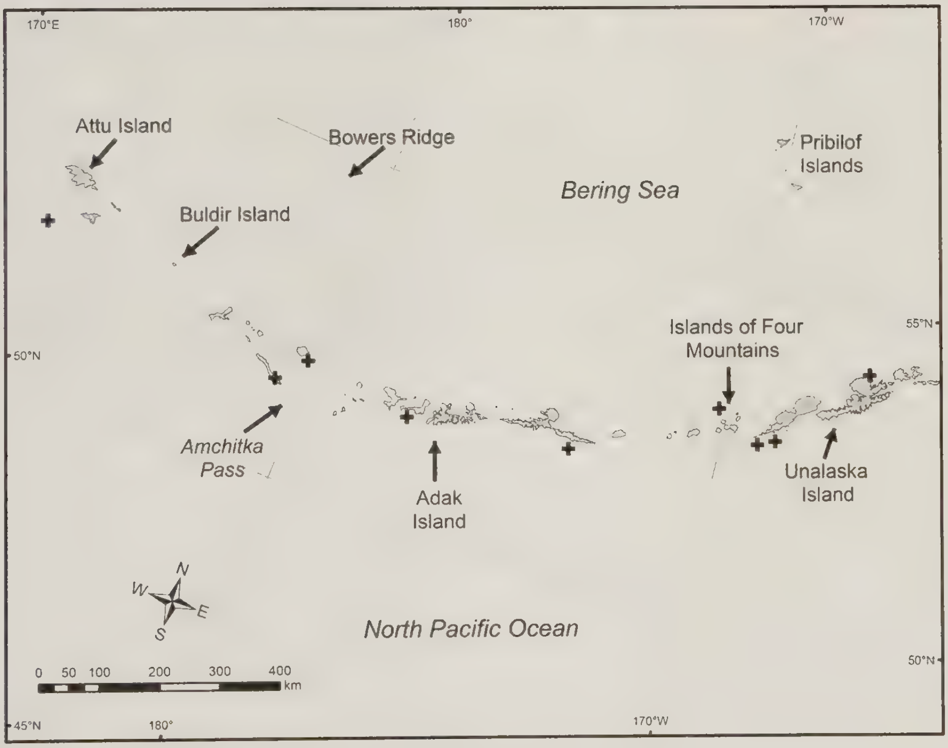

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 3-9

A map of the Aleutian Islands showing the distribution of *Flabellum oclairi* Cairns, sp. nov. (+) in Alaska waters.

7. *Javania borealis* Cairns, 1994

Description (Adapted from Cairns, 1994) The skeleton is solitary, trochoid, and attached by a stereome-reinforced pedicel up to 11 mm in diameter. The calice is elliptical and slightly serrate. The largest specimen is 35 mm in height and 36×28 mm in calicular diameter (greater calicular diameter to lesser calicular diameter of 1.3). The theca is smooth, white, and porcelaneous; the polyps are typically white or pale orange at shallow depths but orange in deeper waters.

Septa are hexamerally arranged in five complete cycles (96 septa) with a formula of S1–2>S3>S4>>S5. Septa are not exsert, thin and quite fragile, and have slightly sinuous axial edges. Pali are absent; the fossa is deep; a columella is absent.

Remarks *Javania borealis* is distinguished from the only other Alaska species, *J. cailleti* (Duchassaing and Michelotti, 1864), by having five (not four) cycles of septa. Otherwise, it closely resembles *Flabellum* (*Flabellum*) *oclairi* sp. nov. in many features, but differs in having a stereome-reinforced pedicel (characteristic of the genus) and sinuous axial septal edges. The ten Recent species of the genus *Javania* are keyed by Cairns (2004).

Distribution In Alaska – Aleutian Islands (north of Unalaska Island to northeast of Attu Island) including Petrel Bank (Fig. 3-10). Elsewhere – the only other known record is from the Sea of Japan (west of Hokkaido).

Habitat In Alaska – grows on bedrock and other hard substrate at depths between 17 and 1266 m. Elsewhere – at depth of 347 m.

Photos A) A calicular view of a dried *J. borealis* specimen (USNM 1011164) collected northwest of Adak Island, central Aleutian Islands, at a depth of 150 m. B) A fresh *J. borealis* specimen (USNM 1086634) collected west of Bobrof Island, central Aleutian Islands, at a depth of 17 m. C) A lateral view of the same specimen in photo A. D) A patch of *J. borealis* in the central Aleutian Islands at a depth of 1266 m. E) A close-up view of a patch of *J. borealis* in the central Aleutian Islands at a depth of 1258 m. The distance between the red laser marks in photos D and E is 10 cm.

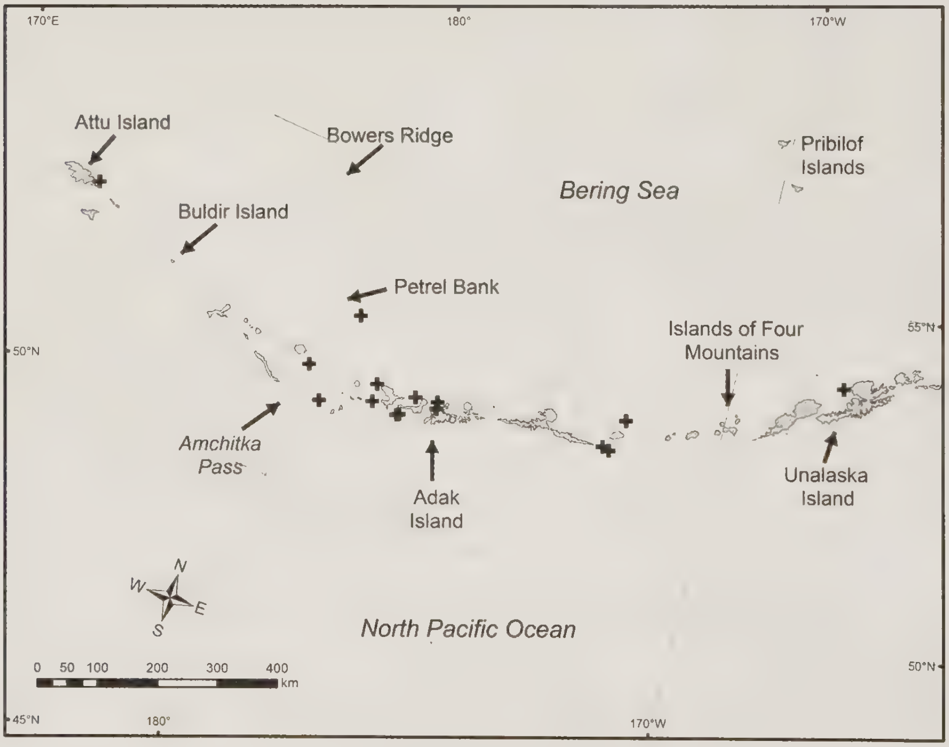
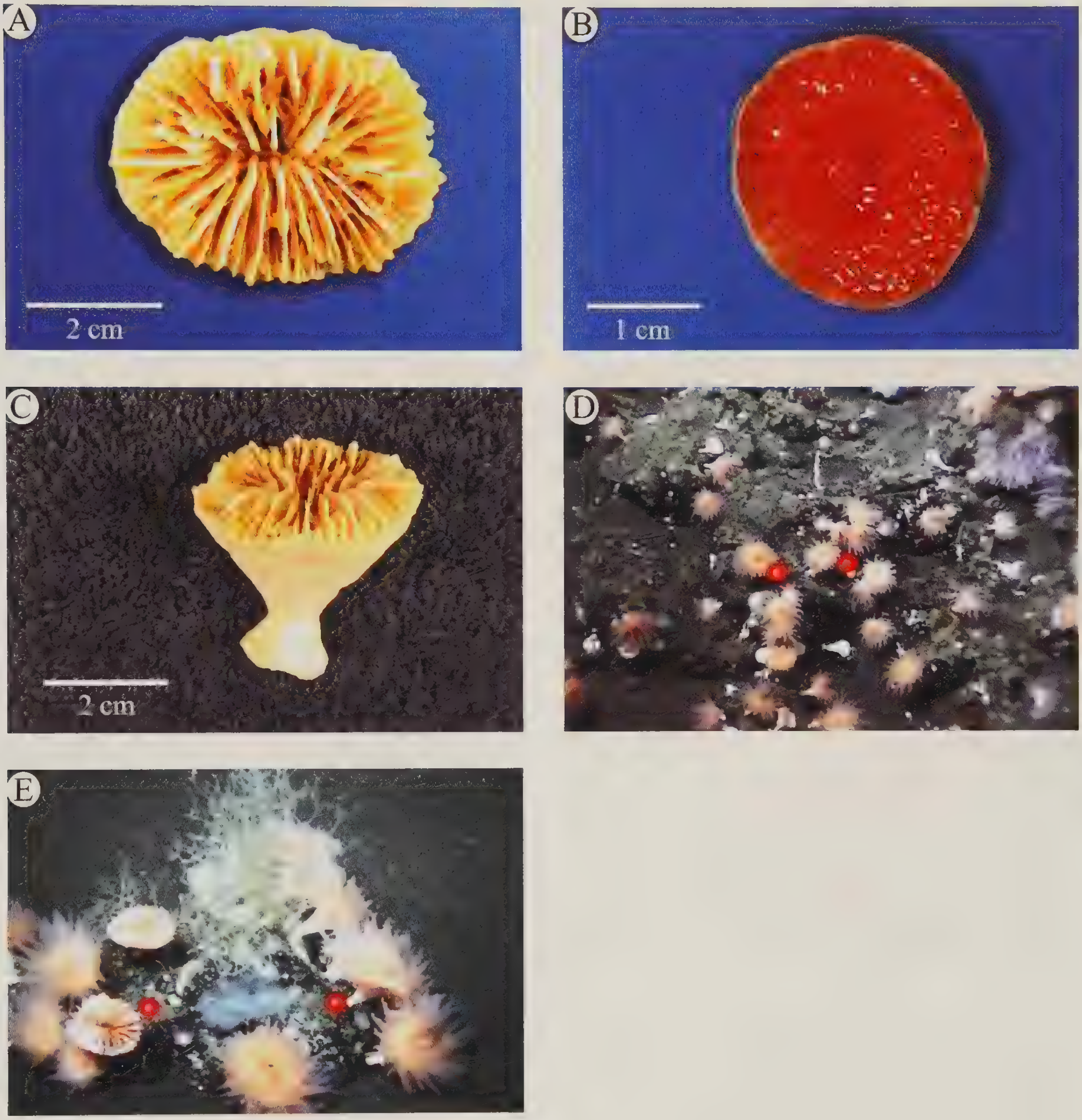


Figure 3-10

A map of the North Pacific Ocean showing the distribution of the *Javania borealis* (+) in Alaska waters.


A
2 cm
B
1 cm
C
2 cm
D
E

8. *Javania cailleti* (Duchassaing and Michelotti, 1864)

Description The skeleton is solitary, ceratoid, and firmly attached by a robust stereome-reinforced pedicel up to 14 mm in diameter; the pedicel may be curved. Specimens measure up to 46 mm in height; the calice is elliptical and up to 31 mm in greater diameter; the upper corallum is distally flared. The theca is smooth, white, and porcelaneous; the polyps are typically light orange or light pink.

Septa are hexamerally arranged in four complete cycles (48 septa) with a formula of S1–2>S3>S4; the S1–2 is usually highly exsert. The axial edges of larger septa are straight and their lower edges fuse into a rudimentary solid columella deep in the fossa.

Remarks This species is compared to *J. borealis* in the previous species account. It is one of four species in the genus to have only four cycles of septa (Cairns, 2004).

Distribution Uncommon. In Alaska – known from only three specimens (representing the northernmost in the world) collected from two locations in the central Aleutian Islands (including Amchixtam Chaxsxii) and a single location in the Gulf of Alaska Seamount Province (Giacomini Seamount), but also observed on video footage collected on Welker, Quinn, Giacomini, and Murray Seamounts (Fig. 3-11). Elsewhere – widespread and common (Cairns, 1994). Pacific Ocean records include a single record from the Strait of Juan de Fuca (British Columbia), Hawaii, Hokkaido (Japan), and New Zealand. Also reported from the Southeast coast of the United States, Gulf of Mexico and Caribbean Sea, off both coasts of South America, and the Azores.

Habitat In Alaska – grows singly and occasionally in small clusters on fractured bedrock, basalt, and cobbles at depths between 150 and 1799 m. But observed much deeper on video footage collected on Welker (1783–2635 m), Quinn (2100–2373 m), Giacomini (2431–2476 m), and Murray (1787 m) Seamounts. Elsewhere – grows on hard rock at depths between 78 and 1809 m.

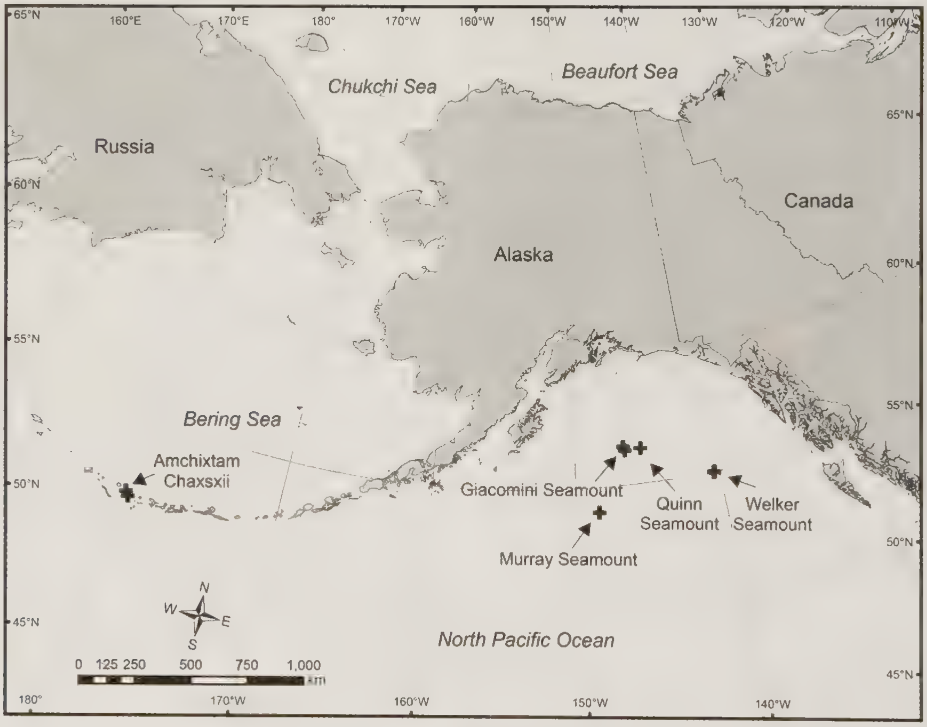
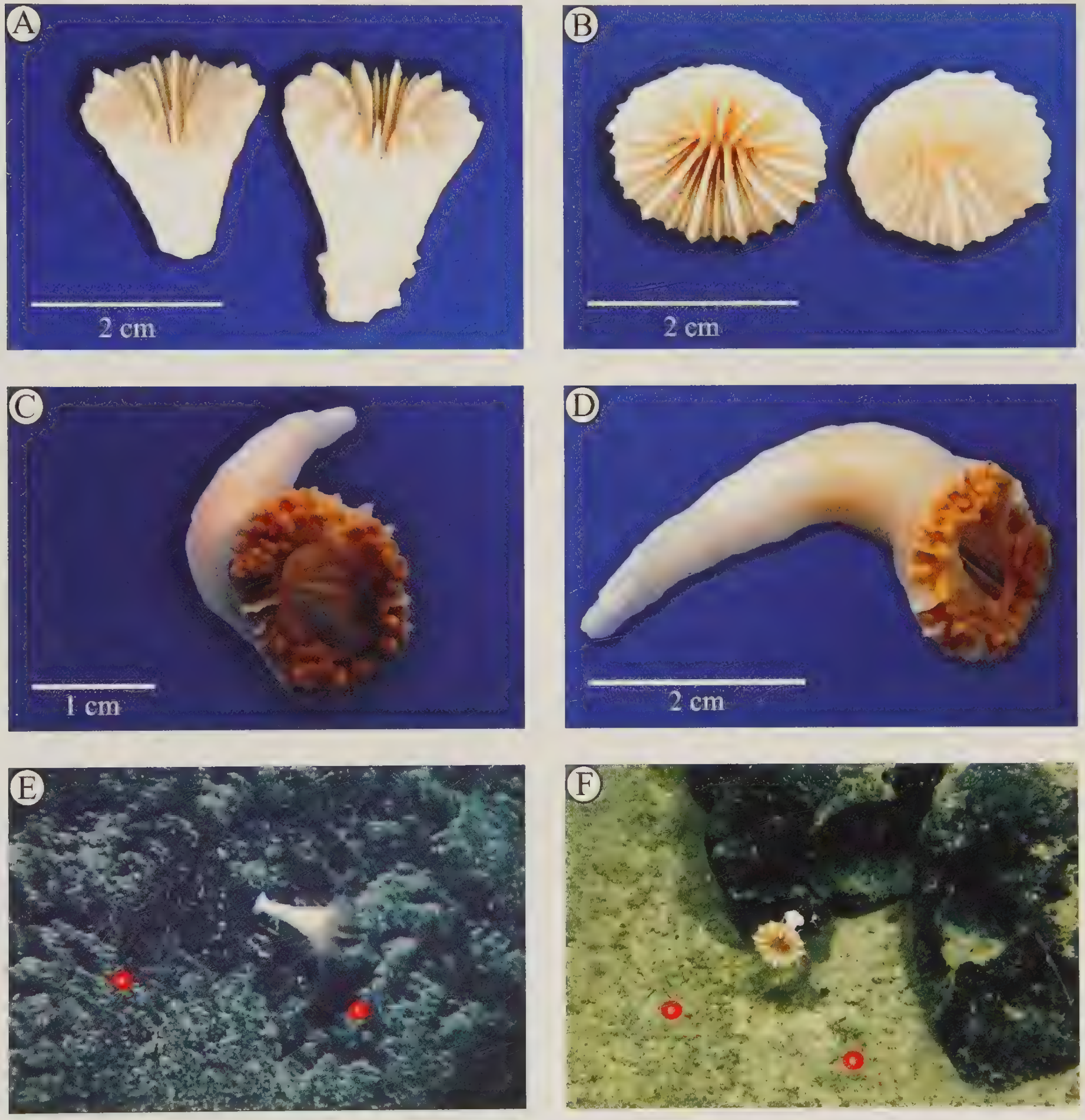

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
Amchixtam
Chaxsxii
50°N
Giacomini Seamount
Quinn
Seamount
Welker
Seamount
50°N
Murray Seamount
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 3-11

A map of the North Pacific Ocean showing the distribution of *Javania cailleti* (+) in Alaska waters.

Photos A) A lateral view of dried *J. cailleti* specimens (USNM 62021) collected off northeastern Little Abaco Island, Bahamas, North Atlantic Ocean, at a depth of 288 m. B) A calicular view of the same specimens in photo A. C) A preserved (in ethanol) *J. cailleti* specimen (USNM 1075808) collected on Giacomini Seamount at a depth of 1799 m. D) A lateral view of the same specimen in photo C. E) *Javania cailleti* photographed on Giacomini Seamount at a depth of 1804 m. F) *Javania cailleti* photographed on Quinn Seamount at a depth of 2350 m. The distance between the red laser marks in photos E and F is 10 cm.



Family Fungiacyathidae

9. *Fungiacyathus (Bathyactis) marenzelleri* (Vaughan, 1906)

Description The corallum is solitary, discoidal, free-living (not attached), and has a flat base covered with finely serrate, ridged costae. Coralla measure up to 27 mm in diameter. The skeleton is white to light brown; the polyps are pale white to light pink.

Septa are hexamerally arranged in four cycles; only the S1–2 is independent, reaching the columella. Pairs of S3 fuse with adjacent S2 and pairs of S4 fuse to adjacent S3, forming triangular canopies at the point of fusion. Upper edges of the septa bear numerous elongate trabecular spines; the septal faces are ridged. The columella is circular, consisting of a mass of trabecular spines, similar to those on axial septal edges.

Remarks *Fungiacyathus* (*Bathyactis*) *marenzelleri* is one of two species known from Alaska waters that has an unattached corallum, the other being *Leptopenus discus*. It is distinguished from *Leptopenus* by having typical (non-bifurcating) higher cycle septa, and septa that correspond to their costae (in *Leptopenus* they alternate). The reproductive ecology of this species has been studied from specimens collected in the Northeast Pacific Ocean off central California at a depth of 4100 m (Flint et al., 2007).

Distribution Uncommon. In Alaska – known only from the deep continental slope region of the central and western Gulf of Alaska including Derickson Seamount. But also observed on video footage collected on Quinn Seamount at depths between 2370 and 2371 m (Fig. 3-12). Elsewhere – widespread and common (Cairns, 1994); Pacific Ocean (Japan and the Kurile Islands, California and Baja Mexico, and New Zealand) and the Atlantic Ocean from Greenland to Antarctica.

Habitat In Alaska – free-living (not attached) in areas of soft sediment (fine sand and silt) with low current in very deep water (2370–6328 m). The latter record is the deepest known for any scleractinian species worldwide. Observed on video footage in patches up to 4 corals/m^2. Elsewhere – found in areas of soft sediment in deep water but eurybathic (300–4882 m). The shallowest records are from Antarctica.

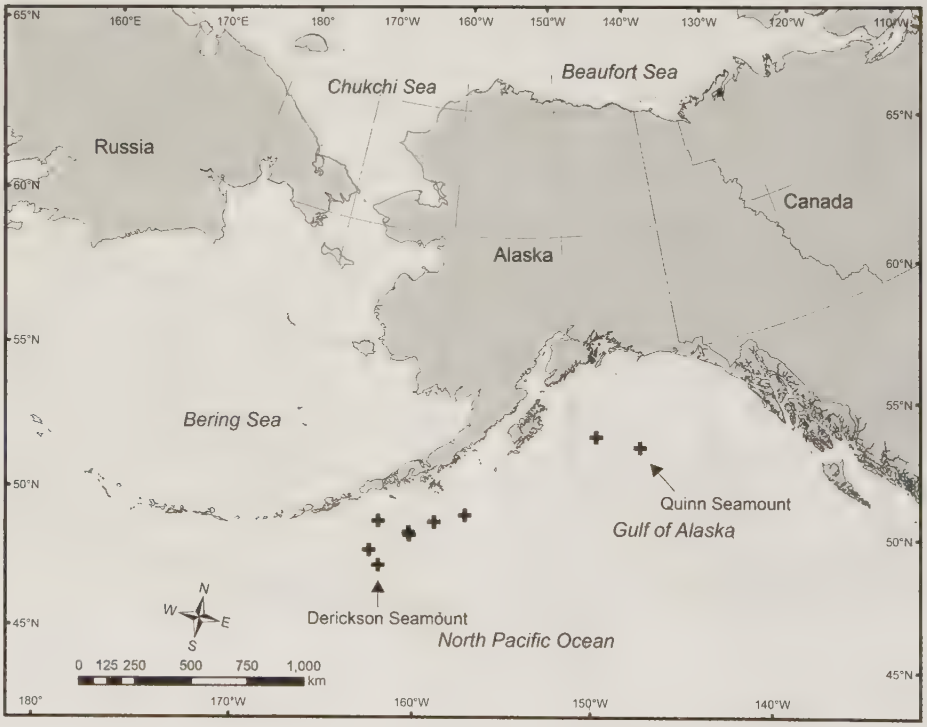
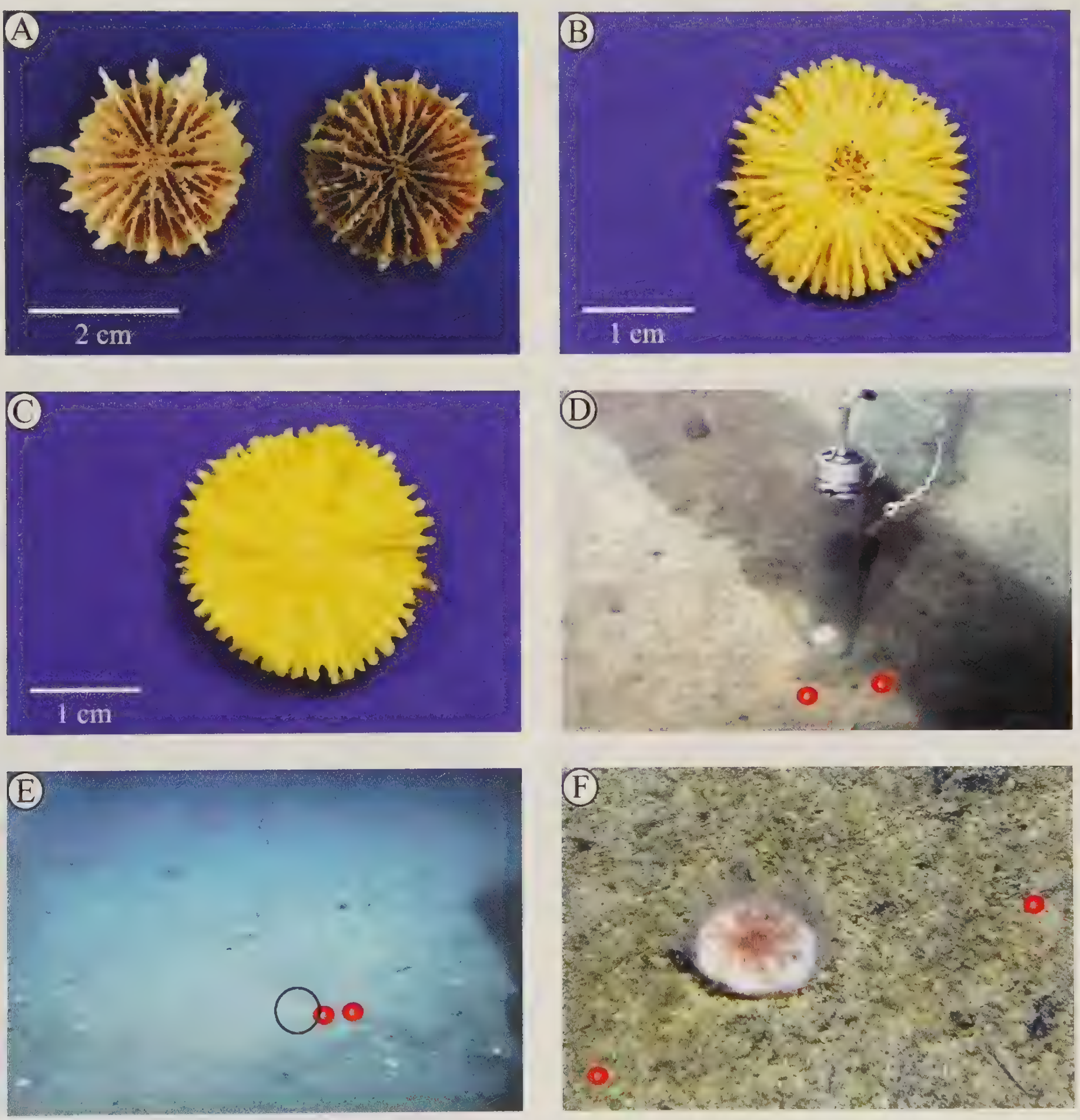

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
65°N
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Quinn Seamount
Gulf of Alaska
50°N
N
W
E
S
45°N
Derickson Seamount
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 3-12

A map of the North Pacific Ocean showing the distribution of *Fungiacyathus marenzelleri* (+) in Alaska waters.

Photos A) A calicular view of two dried *F.* (*B.*) *marenzelleri* specimens (USNM 98974) collected west of the Channel Islands (California) at a depth of 4100 m. B) A calicular view of a dried *F.* (*B.*) *marenzelleri* specimen (USNM 1081142) collected on Derickson Seamount at a depth of 4704 m. C) A ventral view of the same specimen in photo B. D) A photograph of the same specimen in photo B during collection. E) A patch of *F.* (*B.*) *marenzelleri* in situ. Specimen USNM 1081142 is visible within the black circle. F) *Fungiacyathus* (*B.*) *marenzelleri* photographed on Quinn Seamount at 2371 m. The distance between the red laser marks in photos D–F is 10 cm.



Family Micrabaciidae

10. *Leptopenus discus* Moseley, 1880

Description The corallum is solitary, discoidal, and free-living (not attached); the largest known specimen is 25 mm in diameter. The base is flat, and the costae alternate in position with the septa with a row of large pores occurring between each adjacent costa and resulting in an extremely fragile skeleton. The skeleton is white; the color of the polyps in life is unknown.

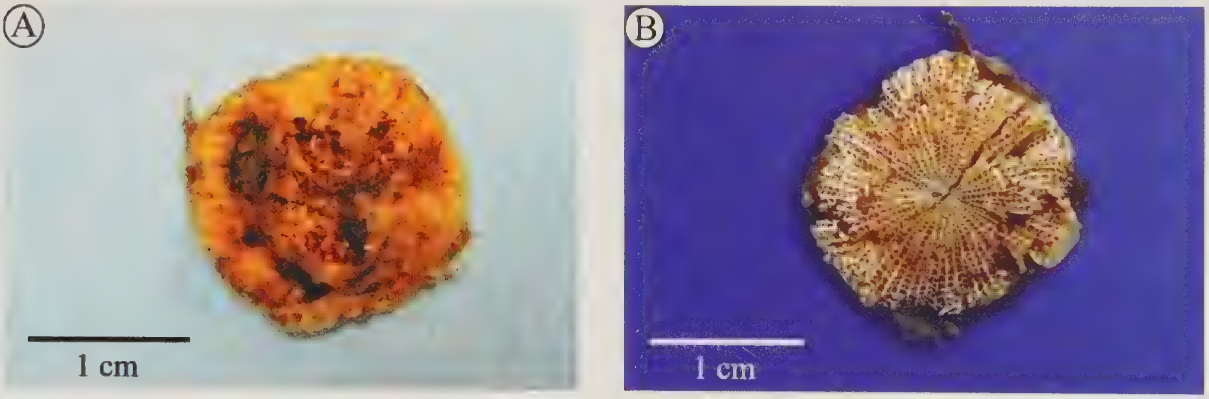
Septa S1–2 extend from the columella to the calice edge, each septum bearing a series of spines on its upper edge. Septa S3 also originate at the columella but appear to bifurcate repeatedly one to three times, resulting in relatively short septa at the calicular margin. Altogether there are 48–72 septa in an adult corallum. The columella is a spinose central mound.

Remarks All micrabaciids, including *Leptopenus*, are distinctive in having septa that alternate with costae and a unique septal arrangement in which the S3 appear to bifurcate repeatedly. They are all quite fragile, usually damaged during collection, and their skeleton is held together only by their tissue. This species was originally described as *L. irinae* Keller, 1977, which is now considered a junior synonym of *L. discus*.

Distribution In Alaska – known only from two specimens collected on the deep continental slope in the western Gulf of Alaska (Fig. 3-13). Elsewhere – widespread but rarely collected, especially intact. Known from off Washington and southern California in the North Pacific Ocean and near Cuba in the North Atlantic Ocean.

Habitat In Alaska – collected at depths between 4820 and 5000 m. Elsewhere – collected at depths between 2842 and 4655 m.

Photos A) A dorsal view of a dried *L. discus* specimen (USNM 93938) collected on Fieberling Guyot, west of the Channel Islands (California) at a depth of 4100 m. B) A ventral view of the same specimen in photo A.



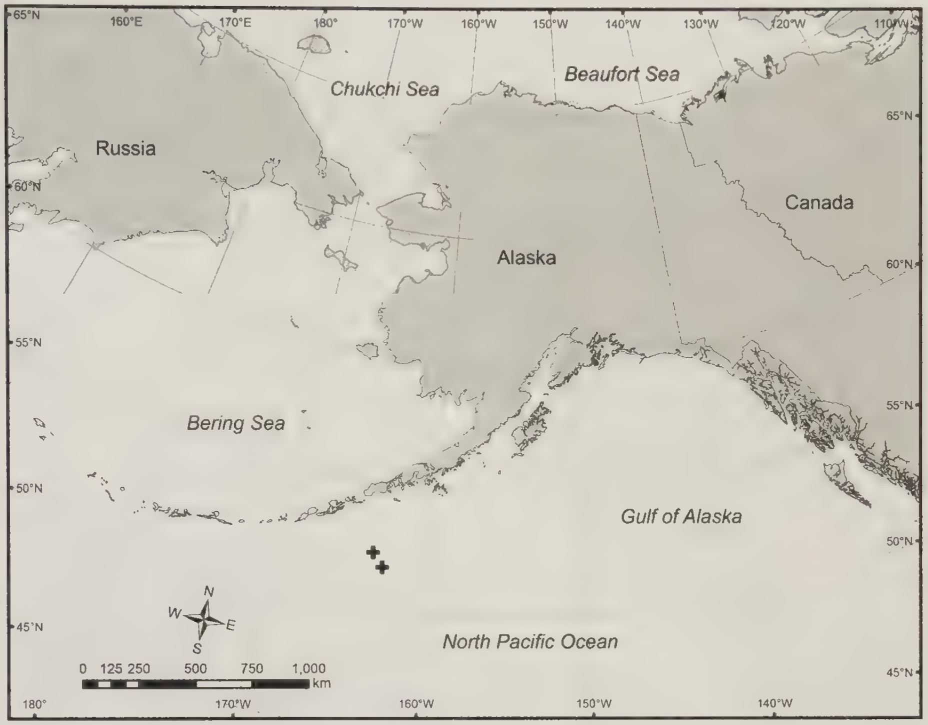

Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 3-13

A map of the North Pacific Ocean showing the distribution of *Leptopenus discus* (**+**) in Alaska waters.

CHAPTER 4

Order Zoantharia

Corals in the order Zoantharia (Class Anthozoa, Subclass Hexacorallia) are generically referred to as "zoanthids" but the correct term is simply "zoantharians." They are often mistaken for actiniarians (true sea anemones) so are largely ignored by marine biologists and seafloor ecologists with the goal of studying more traditional corals (i.e., those with a noticeable hard skeleton made of calcium carbonate). They are also often overlooked given their small size and rather inconspicuous habitus and there is even debate as to whether they are actually corals. We include them in this guide because they appear to be more common than previously thought and are ecologically important in habitats where they occur. They have been poorly documented in Alaska waters until recently. Here we recognize four distinct taxa from two families (Epizoanthidae and Parazoanthidae) in Alaska waters, two of which are epizoic; one (gen. nov., sp. nov.) on hexactinellid sponges and the other (*Zibrowius* cf. *ammophilus*) on octocorals and occasionally antipatharians. We note that this group of corals is in desperate need of taxonomic attention. All encountered specimens should be carefully collected, cataloged, and preserved in ethanol (minimum 70%) or deep frozen for both morphological and molecular phylogenetic study.

Zoantharians are colonial corals in which the polyps arise from a basal tissue, the coenenchyme, which can form a mat or stolon containing gastrodermal canals. Each polyp has two rings of tentacles and they are never pinnate. Colonies very rarely have an intrinsic skeleton but most species incorporate sand, sponge spicules, and other debris particles into the thick body wall or mesogloea. The pharynx is flattened and contains a single siphonoglyph. Mesenteries are numerous but typically with weak musculature.

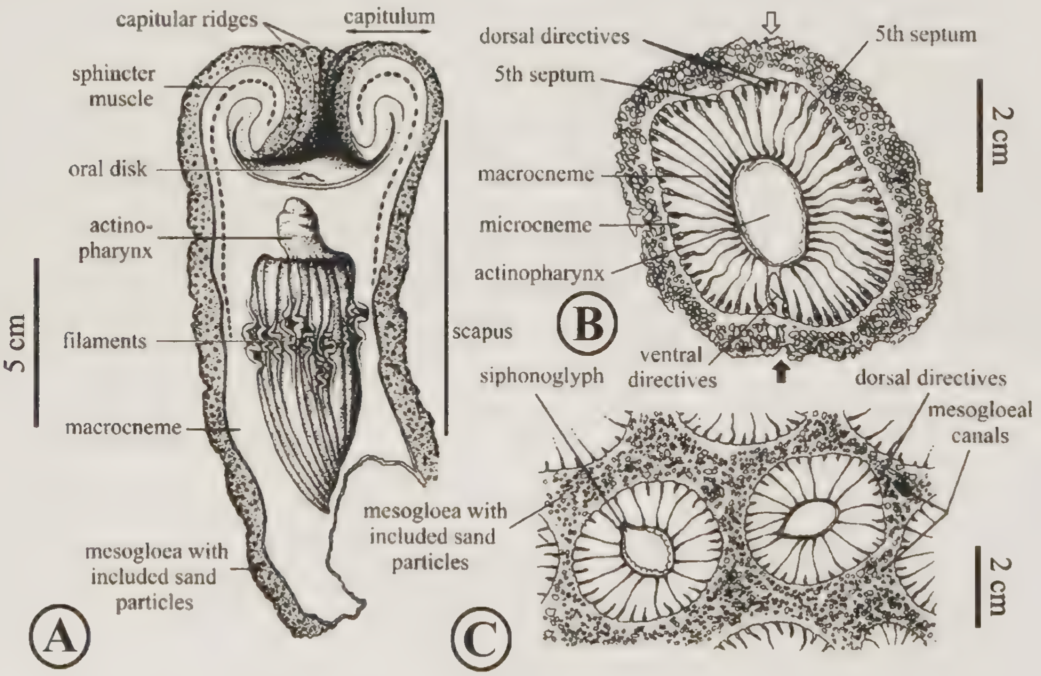

capitular ridges
capitulum
sphincter muscle
oral disk
actino-pharynx
5 cm
filaments
macrocneme
scapus
mesogloea with included sand particles
A
dorsal directives
5th septum
5th septum
2 cm
macrocneme
microcneme
actinopharynx
B
ventral directives
siphonoglyph
dorsal directives
mesogloeal canals
mesogloea with included sand particles
2 cm
C

Figure 4-1

Illustrations of typical corals in the order Zoantharia showing diagnostic morphological features. (A) A planular-section of a polyp. (B) A cross-section of a zooid showing the septal arrangement. (C) The view of a horizontal-section through a colony. Adapted from Ryland and Lancaster (2003).

Diagnostic morphological features (Fig. 4-1) of the zoantharian fauna have traditionally included 1) the anatomy and position of the sphincter muscle, 2) the relationship between the number of septa and polyp column diameter, and 3) the complement and morphometry of the cnidom (Ryland and Lancaster, 2003). Recently, DNA information based on multiple molecular markers and ecological parameters have played a major role in determining phylogenetic relationships among zoantharians (Sinniger et al., 2010, 2013).

Most species of zoantharians are reported to be gonochoric (either male or female) and the reproductive ecology for at least one Pacific Ocean species, *Savalia lucifica* (Cutress and Pequegnat, 1960) (originally described as *Parazoanthus lucificum* Cutress and Pequegnat, 1960), has been well studied (Cutress and Pequegnat, 1960). In *S. lucifica* the gonads are located on the macrocnemes just below the actinopharynx and are ripe during the summer months. The zoanthella-type larvae are retained within the body wall until they are well developed and are commonly observed in the lumens of the tentacles (Cutress and Pequegnat, 1960). These characteristics indicate that the larvae do not travel far from the parent and likely account for the highly contagious distribution displayed by these corals.

None of the Alaska species are zooxanthellate nor do they appear to emit bioluminescence when disturbed in situ. They are uncommon but can be abundant where they do occur. They are found in the Gulf of Alaska, the Gulf of Alaska Seamount Province, the eastern Aleutian Islands, and the eastern Bering Sea (Fig. 4-2) and are eurybathic fauna ranging in depth from 87 to 2511 m.

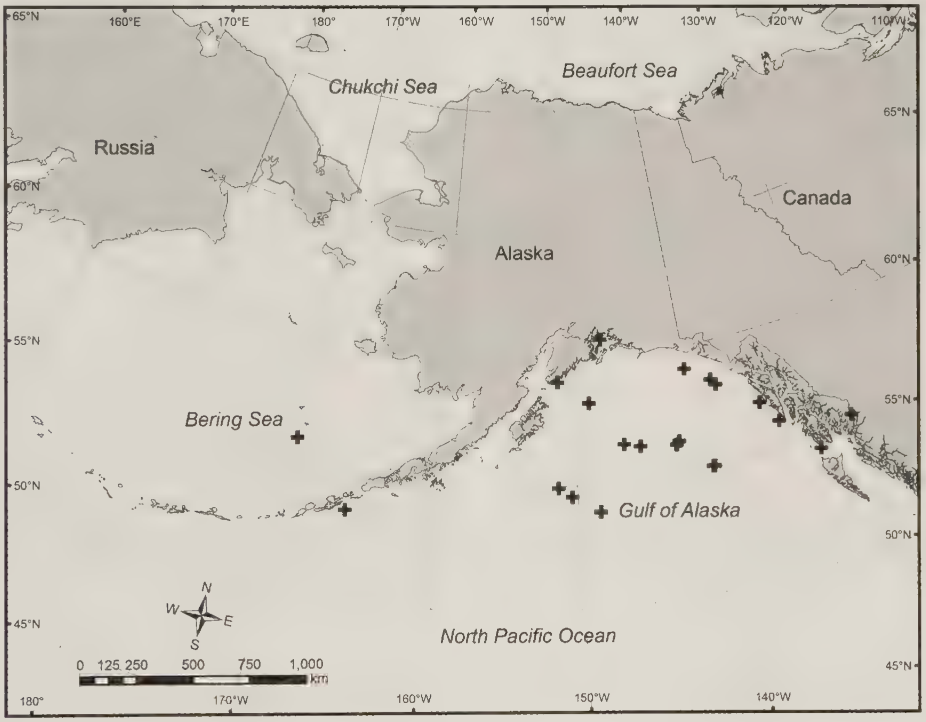

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 4-2

A map of the North Pacific Ocean showing the distribution of corals in the order Zoantharia (+) in Alaska waters.

Family Epizoanthidae

1. *Epizoanthus scotinus* Wood, 1957

Description The original description of this species by Wood (1957) is poorly documented. Additionally, *Epizoanthus* is one of the most difficult genera to identify based on external appearance with the exception of species with very unique morphologies or ecology. Currently, the most reliable identifications rely on simple DNA analyses or histological examination. However, in the case of *E. scotinus*, individual polyps are up to 5 cm in length but colonies forming large irregular mats may cover several square meters or more. Polyps are moderately crowded and each possesses approximately 30 relatively short (up to 22 mm in length), stout but pointed tentacles. Color in life is a golden-orange with a notably lighter oral disc rim and tentacles. The coloration of the larger polyps and the better-developed coenenchyme are good characteristics to distinguish this species from the potentially sympatric *Mesozoanthus lilkweminensis* Reimer and Sinniger, 2010.

The only known Alaska specimen (photos A and B) was attached to an aggregate of fractured bivalve shell and was a globular mass measuring about 6.3×4.4 cm. The colony consists of 14 tubular polyps of variable but quite large size (up to 24 mm in height and 10 mm in width, contracted). Polyps are variably crowded and with a relatively thick coenenchyme that is obviously speckled with black foreign material, likely sand particles. The color of the colony preserved in ethanol is a uniform golden-light brown.

Remarks This species is not known to be epizoic but rather grows directly on bedrock or large boulders and typically does not incorporate particles into the ectoderm or mesogloea.

Distribution Rare. In Alaska – known from only a single specimen collected near Unalaska Island in the eastern Aleutian Islands (Fig. 4-3). Elsewhere – uncommon but locally abundant; widespread throughout the eastern North Pacific Ocean (British Columbia to Cordell Bank, California). According to Lamb and

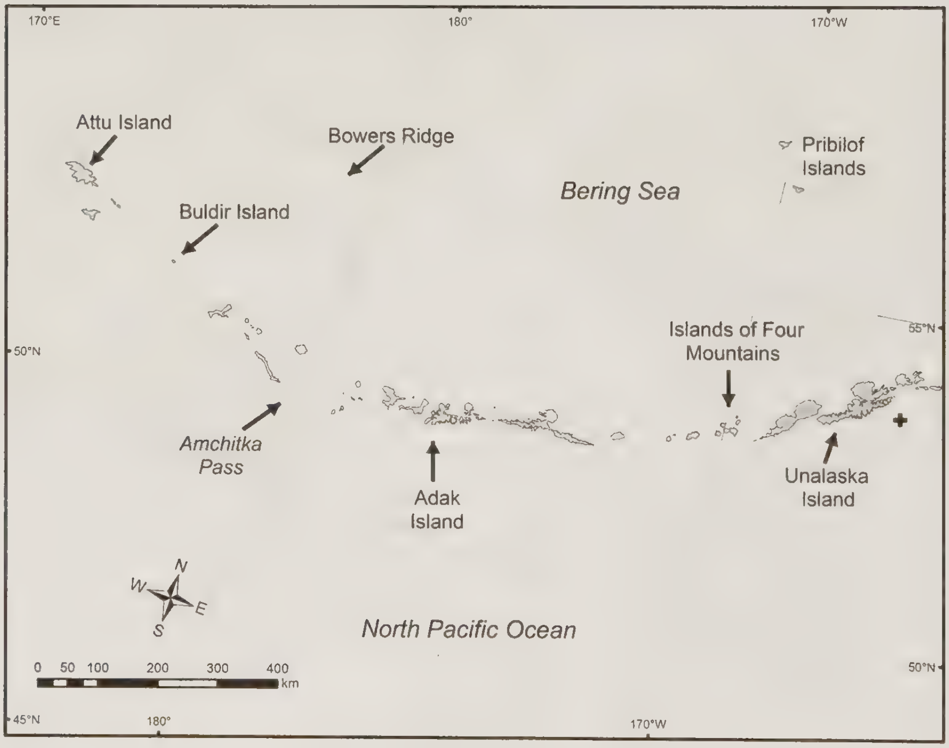


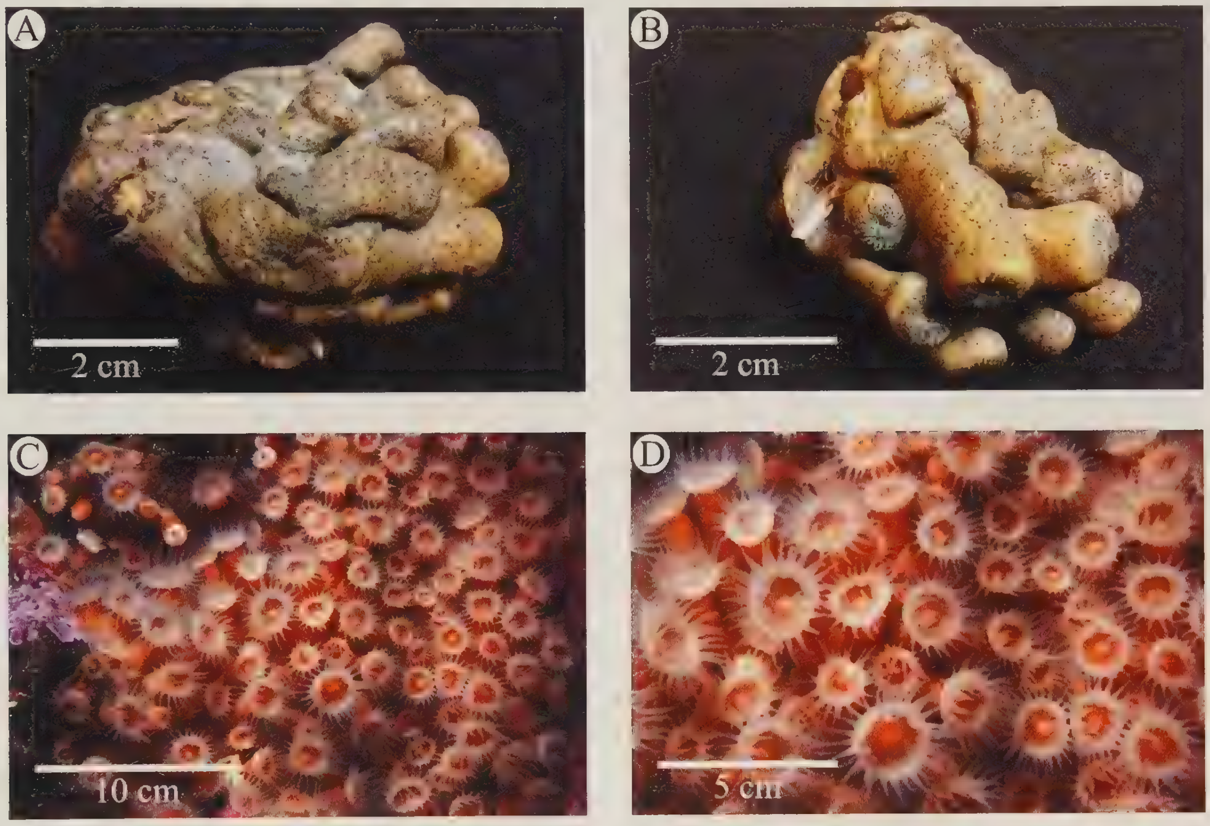
Figure 4-3

A map of the Aleutian Islands showing the distribution of *Epizoanthus scotinus* (+) in Alaska waters.

Hanby (2005) this species is known from Siberia to southern California.

Habitat In Alaska – attaches to cobbles, pebbles, and bivalve shells in areas with moderate to strong currents at depths near 116 m. Elsewhere – often found in nearshore and coastal habitats on vertical or undercut bedrock with moderate currents. Colonies are found in the low intertidal zone (Lamb and Hanby, 2005) to depths of 149 m (off Oregon).

Photos A) A large portion of a preserved (in ethanol) *E. scotinus* colony (CAS 168222) collected in Akutan Pass, eastern Aleutian Islands, at a depth of 116 m. B) An alternate view of the same specimen in photo A. C) A large *E. scotinus* colony photographed in Weynton Passage, central British Columbia, at a depth of about 25 m. D) A close-up view of the polyps on the same colony in photo C. Photos C and D are courtesy of Neil McDaniel.



Family Parazoanthidae

2. *Mesozoanthus* sp.

Description This species is known in Alaska from only a few small specimens collected in Pribilof Canyon (eastern Bering Sea) and observations of similar specimens at 12 locations in the eastern and central Gulf of Alaska. Colonies occur as clusters of 6–50 polyps that form nearly continuous mats covering 5 m^2 or more. Polyps are relatively large, up to 32 mm in length and 12 mm in diameter when contracted, and often increase slightly in width from the base to the distal section of the polyp. Polyps have 24–27 long (up to 14 mm in length), slender tentacles that are the same color as the polyp. Polyps are orangish-brown in color, sometimes with obvious ribbing when contracted, and often speckled with black sand particles. As with other zoantharians, the oral disc is a lighter color than the rest of the polyp.

Remarks There are only two accepted species in the genus: *Mesozoanthus fossii* Sinniger and Haussermann, 2009 and *Mesozoanthus lilkweminensis* (WoRMS Editorial Board, 2022). The former species is from shallow water in Chilean fjords and the latter is from the coastal waters of British Columbia at depths between 37 and 43 m. Based on geographical and bathymetrical differences between the two described species and the one listed here, we suspect that the Alaska specimens may be one or more undescribed species. All specimens suspected of being this taxon should be collected and properly preserved for expert identification.

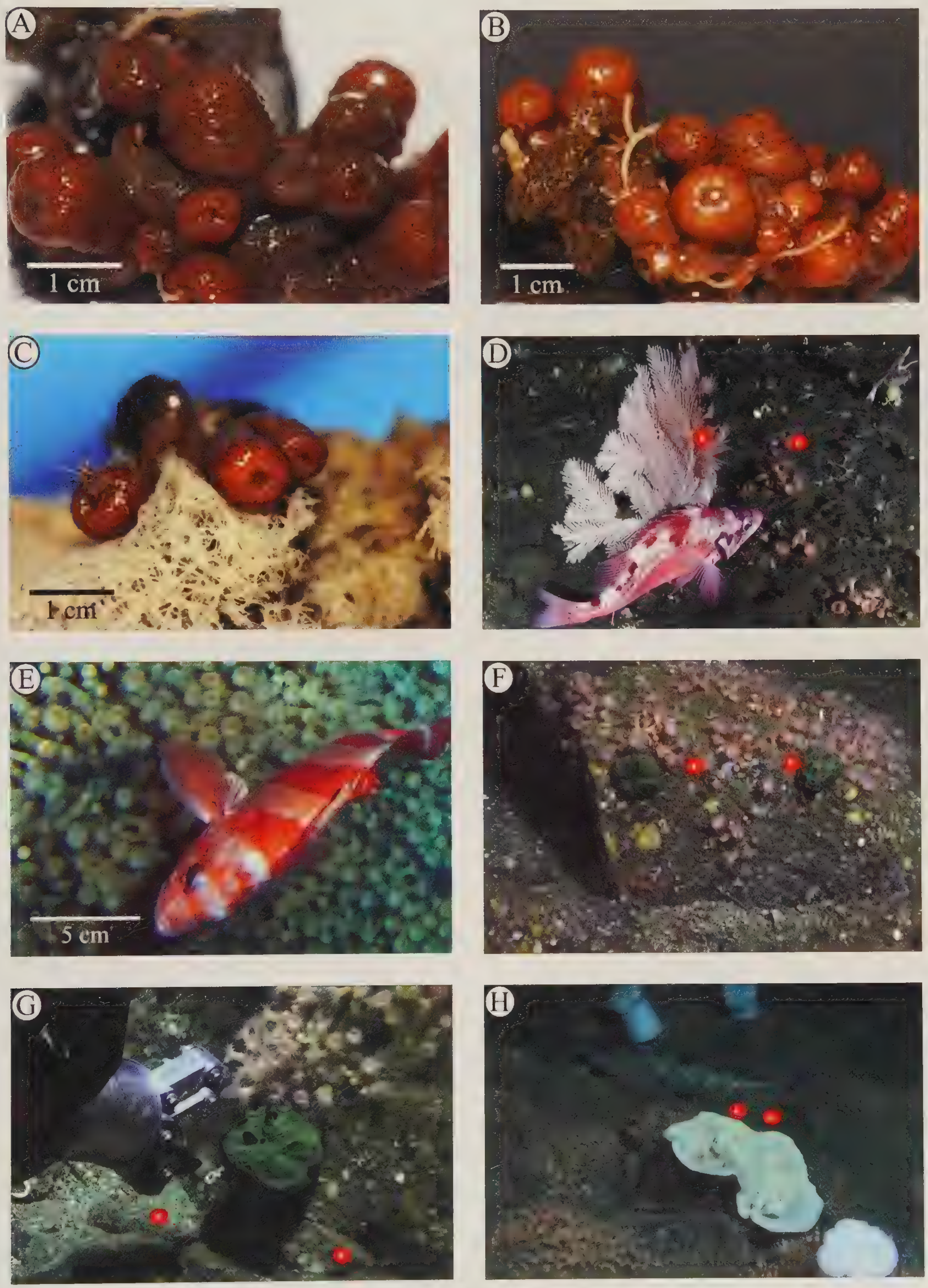
We initially thought this species was epizoic since we observed it growing on live demosponge *Poecillastra tenuilaminaris* (see photo I) in the eastern GOA and on live hexactinellid sponge (*Aulosaccus* sp.) in the eastern Bering Sea (see photo C). Upon closer inspection, however, we determined that in both cases the zoantharians were actually growing on rock fragments or pebbles that were in turn attached directly to the sponges.

This species is preyed upon by the dorid nudibranch (*Peltodoris lentiginosa*), the gunpowder star (*Gephyreaster swifti*), and the spiny red sea star (*Hippasteria phrygiana*) in the eastern GOA.

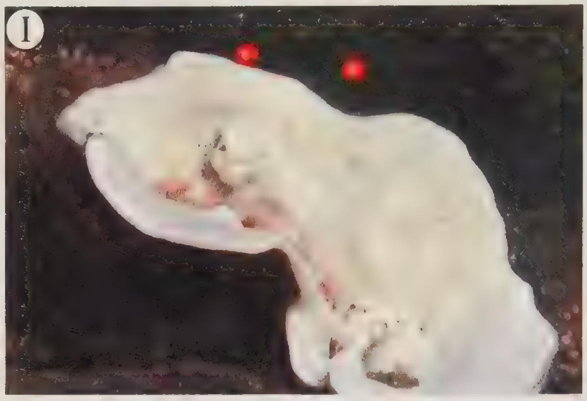
Distribution Uncommon. In Alaska – the GOA from Dixon Entrance to south of the Kenai Peninsula (including Prince William Sound) and Pribilof Canyon in the eastern Bering Sea (Fig. 4-4). Elsewhere – not reported.

Habitat Occurs principally on bedrock including vertical and overhanging walls but also on cobbles and pebbles at depths between 123 and 625 m. Co-occurs in dense mats with the scleractinian *Caryophyllia arnoldi* in Prince William Sound.

Photos A) A *Mesozoanthus* sp. specimen collected in Pribilof Canyon, eastern Bering Sea, at a depth of 208 m. B) An alternate view of the same specimen in photo A. C) A *Mesozoanthus* sp. specimen collected in Pribilof Canyon at a depth of 204 m. The colony is attached to pebbles that were incorporated into the base of the hexactinellid sponge. D) Small *Mesozoanthus* sp. colonies (including the colony in photo A) attached to pebbles in Pribilof Canyon at a depth of 208 m. E) Numerous *Mesozoanthus* sp. colonies attached to bedrock and forming a nearly continuous mat on Portlock Bank in the western GOA at a depth of 197 m. An immature redbanded rockfish (*Sebastes babcocki*) perches on the corals. F) *Mesozoanthus* sp. colonies associated with demosponges (*Latrunculia austini*) in the Edgecumbe Pinnacles Marine Reserve in the eastern GOA at a depth of 161 m. G) A close-up view of the same colonies in photo F. H) Large mats of *Mesozoanthus* sp. colonies in the Edgecumbe Pinnacles Marine Reserve at a depth of 165 m. A lingcod (*Ophiodon elongatus*) perches on the corals. I) The same colonies in photo H showing zoantharians growing on fragmented rock that has fallen from above onto the demosponge *Poecillastra tenuilaminaris*. The distance between the red laser marks in photos D and F–I is 10 cm.


A
1 cm
B
1 cm
C
1 cm
D
E
5 cm
F
G
H

2. *Mesozoanthus* sp. (continued)



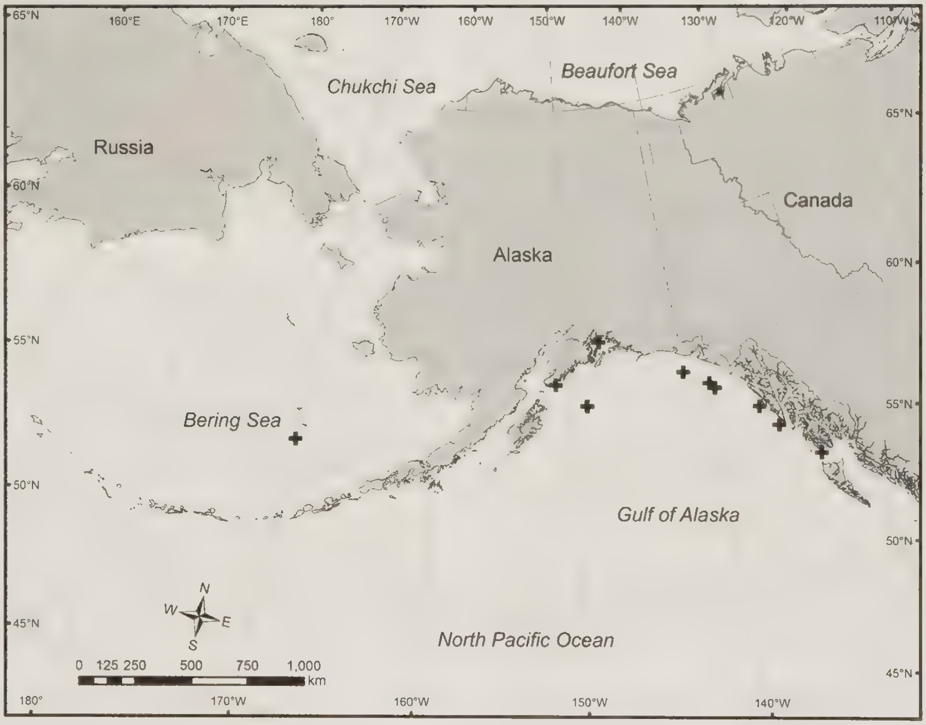

Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 4-4

A map of the North Pacific Ocean showing the distribution of *Mesozoanthus* sp. (+) in Alaska waters.

3. *Zibrowius* cf. *ammophilus*

Preliminarily molecular DNA analysis based on the mitochondrial cytochrome oxidase *c* subunit 1 and 16S markers and the 8S and internal transcribed spacer nuclear markers indicated that specimens recently collected on seamounts in the Gulf of Alaska Seamount Province are likely a novel species, very closely related to *Zibrowius ammophilus* Sinniger et al., 2013. Additional analyses are underway and, if it is a new species, a description will be prepared (Sinniger Harii[4]). The genus *Zibrowius* was established to accommodate a unique group of zoantharians on Cross Seamount near Hawaii (Sinniger et al., 2013). There are three known species in the genus, all from seamounts and all characterized by a well-developed coenenchyme that completely covers the host and has sand incrustations in the ectoderm. This is the first *Zibrowius* species documented from the northern North Pacific Ocean.

Description This is strictly an epizoic species that can form large encrustations covering host coral colonies as large as 70 cm in height by 94 cm in width. Polyps are relatively small (up to 9 mm in length and 5 mm in diameter), variably crowded, and with a very thin coenenchyme. Each polyp has approximately 20 pointed tentacles that are relatively shorter and stouter than those of other Alaska species. The scapus (or column) is somewhat transparent and lighter in color than the capitulum in such a way that the mesenteries are often visible inside the polyp wall. Color of colonies in life is uniform and a bright rusty orange to golden-orange; this variation in coloration is likely due to differential artificial lighting.

Remarks The species completely overgrows or encrusts octocoral colonies, mostly the primnoids *Parastenella ramosa* (Studer, 1894) and *Parastenella gymnogaster* Cairns, 2007, occasionally the gorgoniids *Callistephanus pacificus* Nutting, 1912 and *Callistephanus simplex* (Nutting, 1909) and keratoisidids (*Isidella tentaculum* and *Keratoisis* sp. D), and rarely the antipatharian *Lillipathes* sp. A and fossil hexactinellid (likely *Chonelasma oreia*). Small colonies (less than five polyps) have been observed on the octocoral *Paragorgia* sp. B.

This species has a contagious distribution apparently settling from one colony to neighboring colonies giving the appearance of what we call "infestations." Most host colonies we observed were completely covered with zoantharians (see photos E and G on next page) but occasionally zoantharians covered only a portion of a living host (see photo F on next page). We suspect that the process that occurs for this zoantharian settling on and then overtaking its host is very similar to the process described for *Savalia lucifica* and *Muricea californica* Aurivillius, 1931 (see Cutress and Pequegnat, 1960), where larvae settle directly on living tissue rather than on bare areas of skeleton and then overgrow and kill the host colony in the process. All the host corals we observed have strong holdfasts and persistent skeletons after death providing excellent habitat for the zoantharians, but we observed very few coral skeletons without the zoantharians. This evidence indicates that the zoantharians may be more parasitic than epizoic, a suggestion made previously for Hawaiian seamount Parazoanthidae (Sinniger et al., 2013).

Swarms of euphausiids have been observed in the immediate vicinity of larger colonies, and colonies harbor similar associated fauna (ophiuroids and the sternostylid crab *Sternostylus iaspis*) that the host colony would have in life.

Distribution Uncommon but locally abundant. In Alaska – known only from seamounts in the Gulf of Alaska Seamount Province (Welker, Pratt, Quinn, Giacomini, Murray, Patton, and Marchand Seamounts; Fig. 4-5). Elsewhere – not reported.

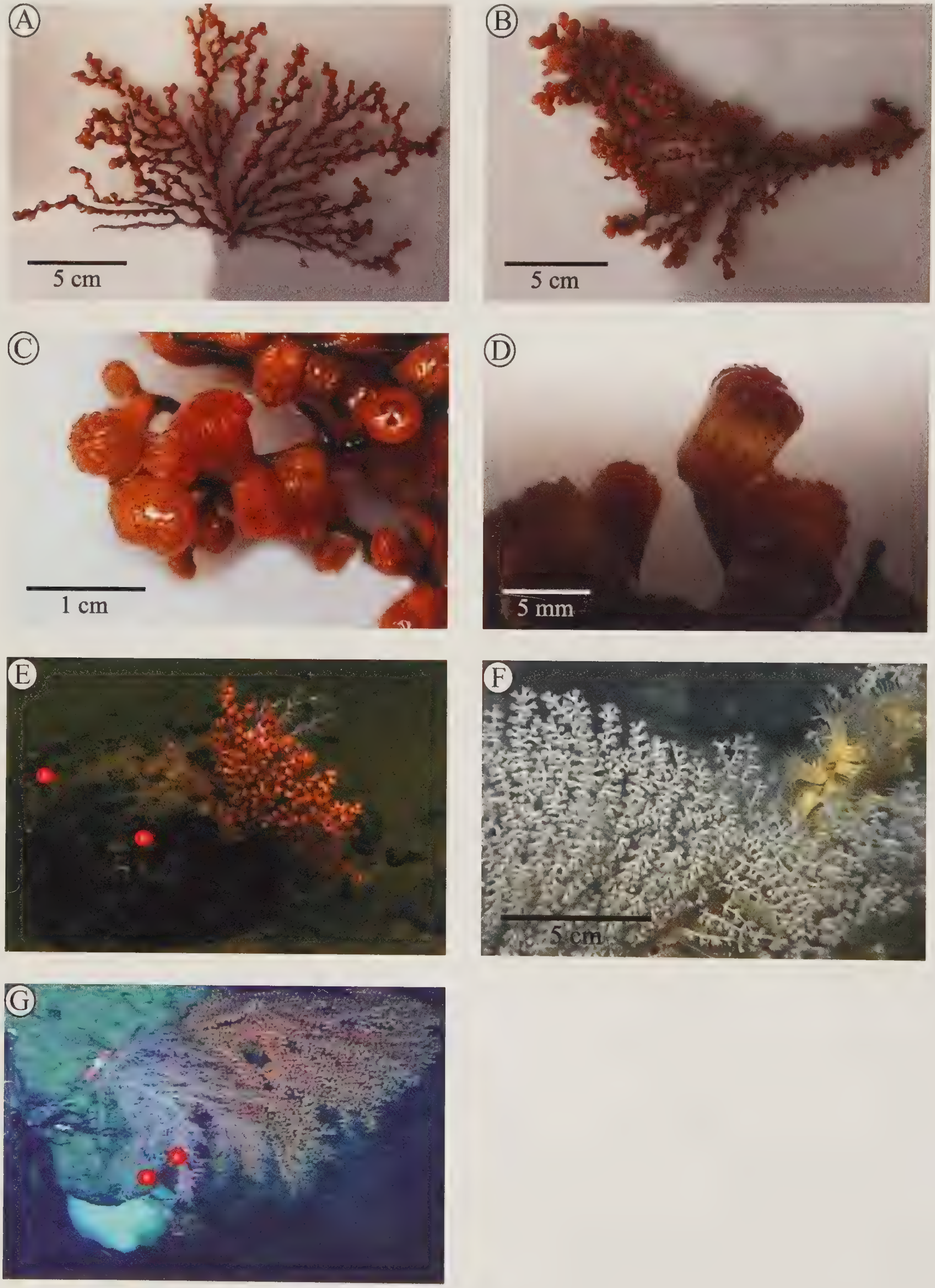
Habitat In Alaska – encrusts octocoral, antipatharian, and hexactinellid sponge skeletons at depths between 745 and 2511 m. Rarely grows on rock alone and likely only when the stolon has overgrown the host colony or skeleton.

Photos A) A whole preserved (in ethanol) *Z.* cf. *ammophilus* colony (NMNH 1661883) collected on Quinn Seamount at a depth of 895 m. The colony completely encrusted a whole *P. ramosa* skeleton. B) A preserved (in ethanol) branch of *Z.* cf. *ammophilus* (NMNH 1661884) collected on Giacomini Seamount at a depth of 745 m. The colony completely encrusted a *P. ramosa* skeleton. C) A close-up view of the same specimen in photo B. D) A zoomed-in view of the same specimen in photo C, showing the mesenteries visible inside the polyp wall. E) The same colony in photo A prior to collection. F) A *Z.* cf. *ammophilus* colony (upper right) newly settled on a *P. ramosa* colony on Pratt Seamount at a depth of 916 m. G) Two *P. gymnogaster* colonies on Marchand Seamount at a depth of 2316 m; a healthy colony (at left) and a colony completely covered with zoantharians (at right). The distance between the red laser marks in photos E and G is 10 cm.

---

[4] Sinniger Harii, F. 2021. Personal commun. Tropical Biosphere Research Center, Univ. Ryukyus, 3422 Sesoko, Motobu 905-0227, Okinawa, Japan.

3. *Zibrowius* cf. *ammophilus* (continued)


A
5 cm
B
5 cm
C
1 cm
D
5 mm
E
F
5 cm
G

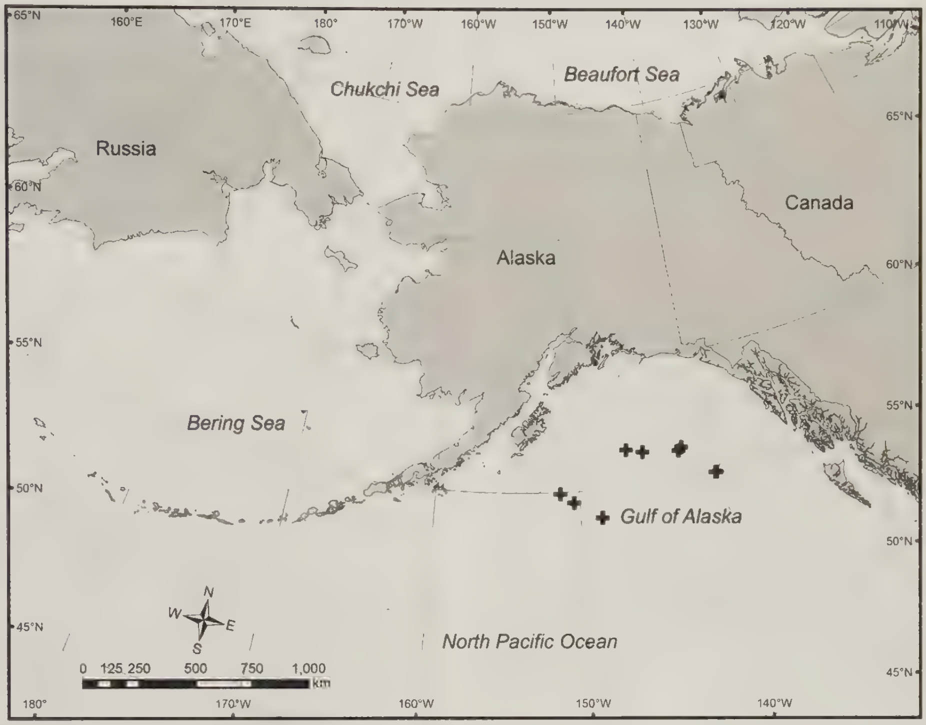

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
Bering Sea
55°N
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 4-5

A map of the North Pacific Ocean showing the distribution of *Zibrowius* cf. *ammophilus* (+) in Alaska waters.

4. gen. nov., sp. nov.

Preliminarily molecular DNA analysis based on the mitochondrial cytochrome oxidase *c* subunit 1 and 16S markers and the 8S and internal transcribed spacer nuclear markers indicated that specimens collected on hexactinellid sponge reefs in Southeast Alaska on the border with British Columbia are a novel genus and species in the family Parazoanthidae. Additional analyses are underway and a new genus and species description are in preparation (Sinniger Harii[4]). There are 16 known genera in the family Parazoanthidae (WoRMS Editorial Board, 2022) and the external appearance of the new specimens most closely resemble *Parazoanthus* but the molecular data clearly distinguish this genus from all other genera in the family Parazoanthidae.

Description Colonies consist of clusters of up to 32 polyps and a very thin coenenchyme. Columns are most often uniformly cylindrical and up to 26 mm in length and 14 mm in diameter in contracted specimens. Particles are not incrusted in the mesogloea of the column or elsewhere. The oral disc is flat but broadly fluted. Each polyp has 22–24 long (about two-thirds the diameter of the scapulus disc in live polyps), slender, pointed tentacles that are a slightly lighter color than the polyp. Color in life and in ethanol is a light golden brown. Unlike other Alaska zoantharians, the oral disc of this species is a darker color than the rest of the polyp.

Remarks An unknown species, apparently a *Parazoanthus*, was collected on Pioneer Seamount off northern California. The depth of that collection is unknown but it was likely quite deep since the specimens had completely overgrown an antipatharian skeleton.

Distribution Uncommon. In Alaska – known only from specimens collected in Portland Canal, Southeast Alaska, on the border with British Columbia (Stone et al., 2013; Fig. 4-6). Elsewhere – Portland Canal, northern British Columbia (same reefs as reported here).

Habitat In Alaska – grows exclusively on the exposed skeletal surfaces of the hexactinellid sponge reefs (87–107 m depth) formed principally by *Aphrocallistes vastus* and *Heterochone calyx* along with oxide crusts.

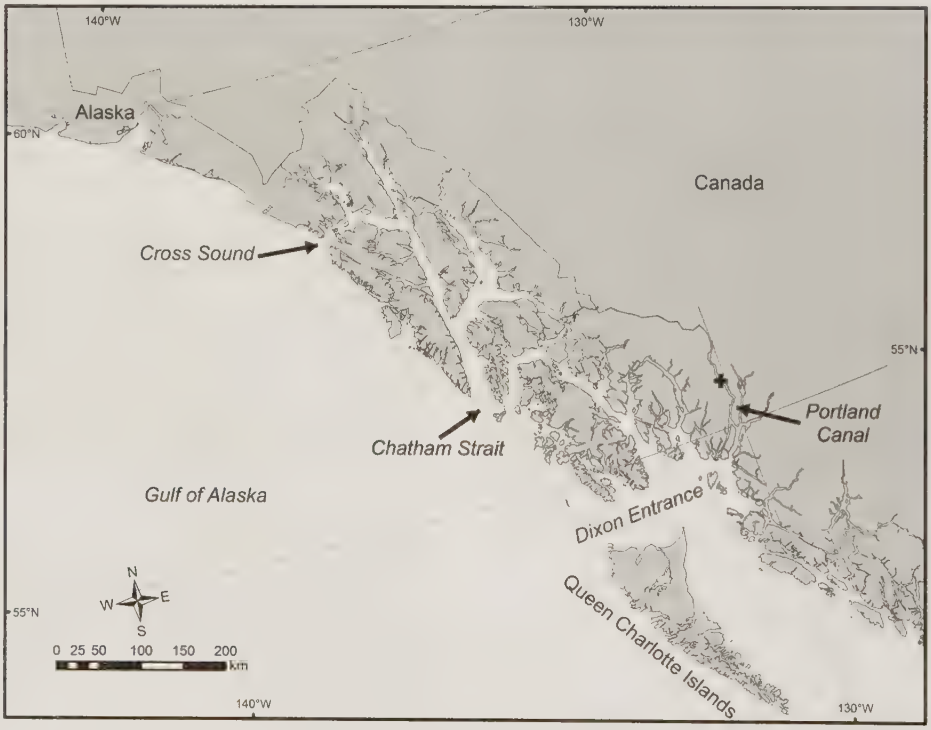
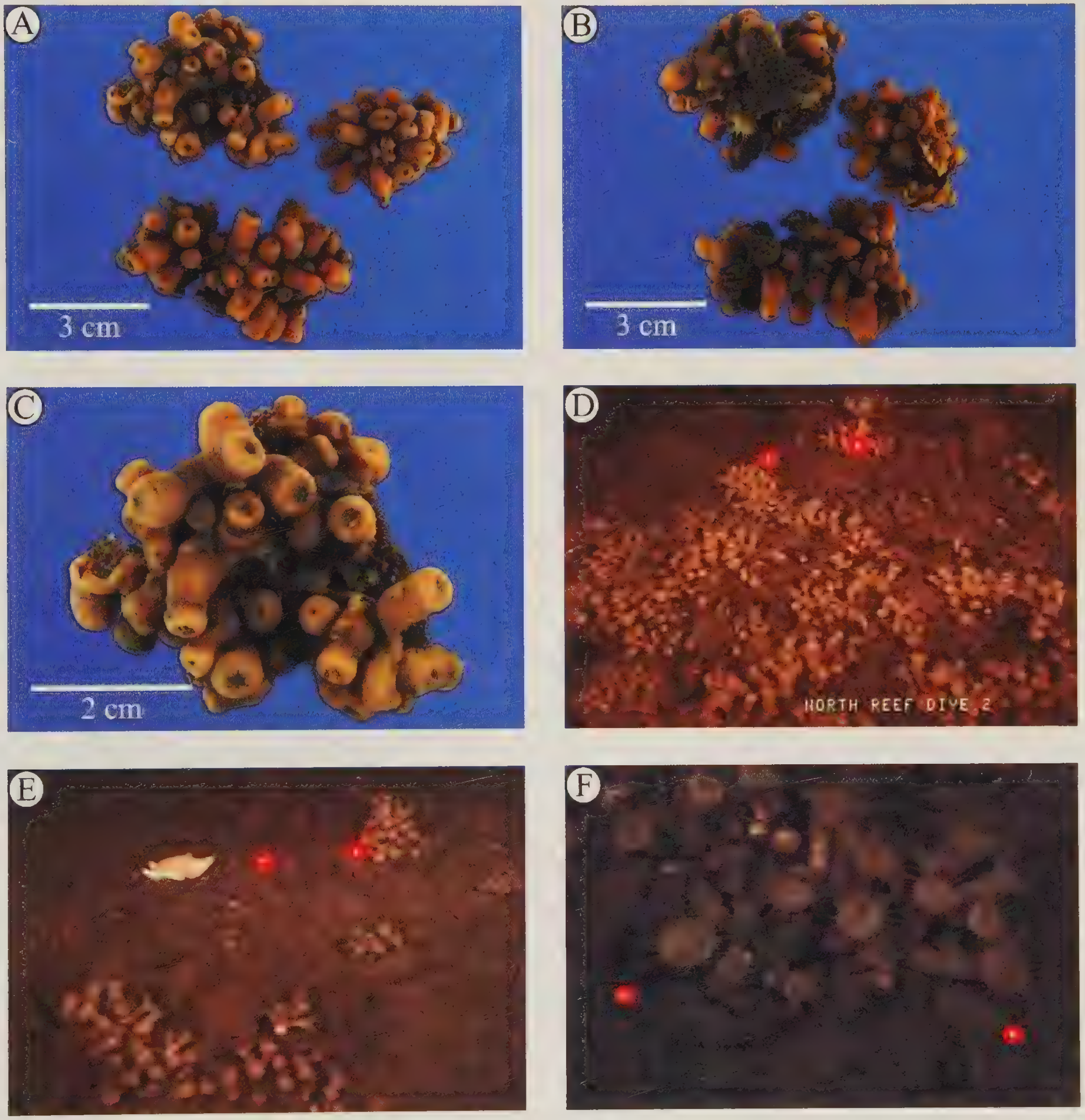


Figure 4-6

A map of the eastern Gulf of Alaska showing the distribution of gen. nov., sp. nov. (+) in Alaska waters.

Photos A) Preserved (in ethanol) portions of gen. nov., sp. nov. colonies (USNM 1482149), photographed from the top, collected in Portland Canal, Southeast Alaska, at a depth of 87 m. B) A ventral view of the same specimens in photo A showing attachment to hexactinellid skeletons. C) A close-up view of the top specimen in photo A. D) Gen. nov., sp. nov. colonies growing on hexactinellid skeletons on the top of the North Reef in Portland Canal, Southeast Alaska, at a depth of 103 m. E) Gen. nov., sp. nov. colonies growing on hexactinellid skeletons on the top of the North Reef in Portland Canal, Southeast Alaska, at a depth of 90 m. F) A close-up view of the same colonies in photo E. The distance between the red laser marks in photos D–F is 10 cm.



CHAPTER 5

Subclass Octocorallia

The Octocorallia are a diverse subclass of colonial anthozoans characterized by the subdivision of the polyp by eight mesenteries, each division giving rise to a tentacle adorned with lateral pinnules, and tissues containing sclerites (Fig. 5-1; Watling et al., 2011). The two monophyletic clades of the Phylum Cnidaria, Medusozoa and Anthozoa (Daly et al., 2007), were recently elevated to the rank of sub-phylum by McFadden et al. (2022) as part of their revised systematics of the Octocorallia based largely on phylogenomics. Additionally, two subclasses of Anthozoa, Hexacorallia and Octocorallia, were elevated to the rank of class. Note that WoRMS has not yet accepted the two rank suggestions made above by McFadden et al. (2022). Two new orders (Malacalcyonacea and Scleralcyonacea) were established to accommodate taxa from the six former suborders in the order Alcyonacea, five of which were represented in Alaska waters—Alcyoniina, Calcaxonia, Holaxonia, Scleraxonia, and Stolonifera. Corals from both orders are common and abundant in most regions of Alaska, particularly in the Aleutian Islands where they are relatively diverse compared to other high-latitude ecosystems worldwide.

The Malacalcyonacea include the majority of taxa in the former suborders Holaxonia and Alcyoniina and many taxa formerly classified as Stolonifera and Scleraxonia (McFadden et al., 2022). The Scleralcyonacea include all corals in the former order Pennatulacea (now superfamily Pennatuloidea), most members of the former Calcaxonia, and a morphologically heterogeneous group of taxa from all five former suborders. Both orders contain taxa with a wide range of growth morphologies, including those with and without skeletal axes (McFadden et al., 2022).

Definitions of the various growth forms and commonly used technical terms can be found in the “Illustrated trilingual glossary of morphological and anatomical terms applied to Octocorallia” by Bayer et al. (1983). In Appendix I we also provide an abbreviated glossary of terms used in this guide for all octocorals, with a separate subsection for Pennatuloideans.

Order Malacalcyonacea

The World Register of Marine Species currently recognizes 46 families in the order Malacalcyonacea, only four of which are represented in Alaska waters—Alcyoniidae, Clavulariidae, Gorgoniidae, and Paramuriceidae. The order also includes corals in 46 genera and two unaccepted families whose phylogenetic positions are still unknown or uncertain and are tentatively listed

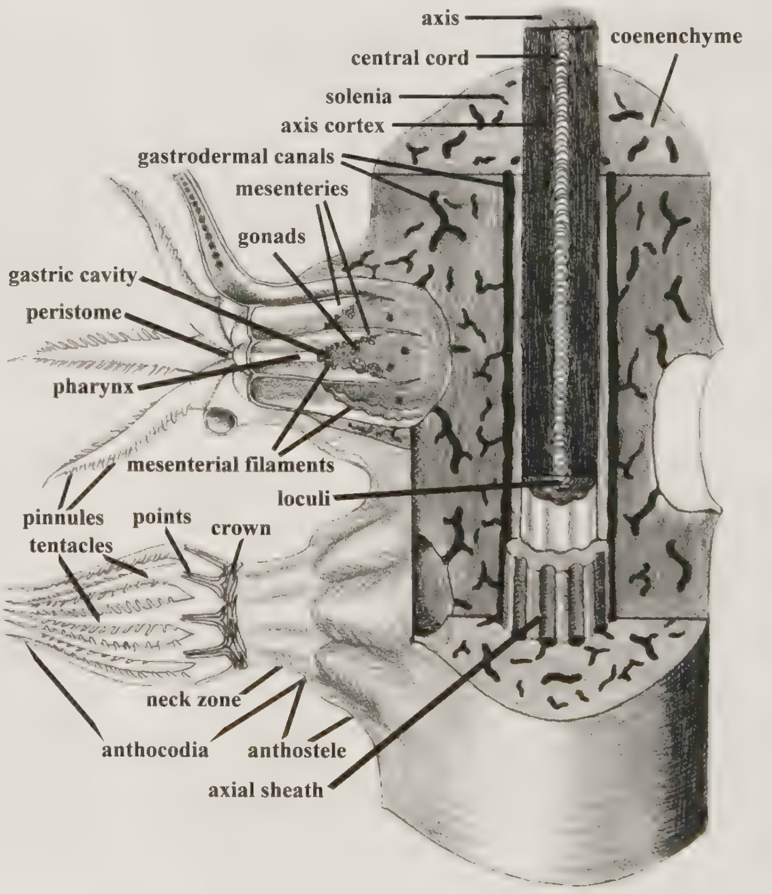


Figure 5-1

A diagram showing the general anatomy of typical octocorals. This figure is adapted from plate 2 in Bayer et al. (1983).

as *incertae sedis* (McFadden et al., 2022). The World Register of Marine Species lists these taxa as the family Malacalcyonacea *incertae sedis*. The vast majority of taxa in the Malacalcyonacea have either a largely proteinaceous or no skeletal axis (McFadden et al., 2022).

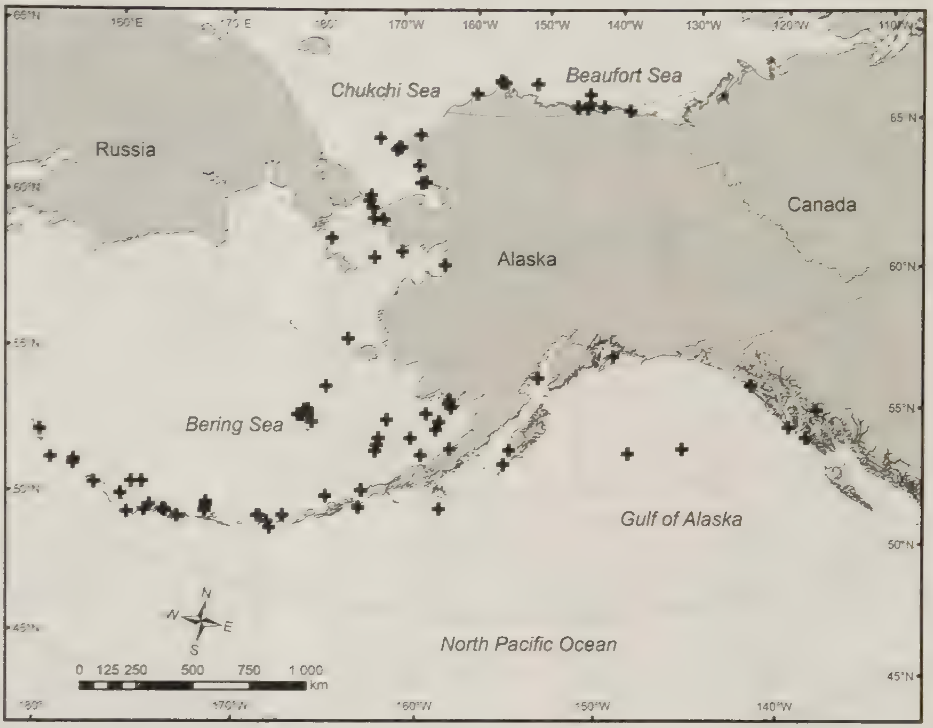


Figure 5-2

A map of the North Pacific Ocean showing the distribution of corals in the family Alcyoniidae (+) in Alaska waters.

Family Alcyoniidae

(Adapted from Fabricius and Alderslade, 2001 and McFadden et al., 2022) The family Alcyoniidae are soft corals in which most or all of the polyps are united in a common, fleshy mass without a supporting axis of horny and/or calcareous material. The coenenchyme is occasionally subdivided into an outer cortex and inner medula. Colonies are membranous, lobate to digitate, arborescent with a single stalk, or bramble-like without a main stalk. Polyps are monomorphic and usually fully retractile into the coenenchyme or prominent calyces. Polyps are distributed over the colony but are sometimes more densely packed on branch tips or terminal lobes. Sclerites are spindles, sticks, rods, clubs, and radiates, and often brightly colored.

In Alaska, the Alcyoniidae include corals in the genera *Alcyonium* and *Gersemia* (until recently designated in the family Nephtheidae) and are found throughout much of the Gulf of Alaska, including a few seamounts in the Gulf of Alaska Seamount Province, the Aleutian Islands where they are most common and abundant, the eastern Bering Sea, and throughout the Arctic region (Fig. 5-2). As a group, they are extremely eurybathic (1–2564 m depth), all attach to hard substrate, and they may be found singly or in dense patches.

The family Alcyoniidae is in need of revision. All *Alcyonium* specimens collected in Alaska should be retained for taxonomic study. Williams (2013) recommends that a taxonomic revision and determination of the validity of *Gersemia rubiformis* be undertaken and specifically notes that North Pacific Ocean specimens may actually be *Alcyonium* rather than *Gersemia*. *Gersemia rubiformis* reportedly has an extremely broad geographical range over much of the North Atlantic, Arctic, and North Pacific Oceans, including most regions of Alaska, so the likelihood that the designation has been misapplied is high. Accordingly, Williams (2013) recommends that molecular studies be done to help determine the taxonomic status of this group. A pilot molecular study was conducted in 2016 in Alaska to help determine the taxonomic status of this group (Everett[5]).The large museum collections and ready access to large numbers of fresh specimens in Alaska presents an ideal opportunity to undertake a much-needed re-examination of the family in the North Pacific Ocean.

We list here six taxa found in Alaska waters, only four of which have definitive taxonomy: *Alcyonium pacificum* Yamada, 1950; *Gersemia fruticosa* (Sars, 1860); *G. Lambi* Williams, 2013; and *G. rubiformis*. The group *Alcyonium* spp. includes specimens other than *A. pacificum* that may represent one or more species, either not yet described or one of two other species, *Scleronephthya spiculosa* (Kükenthal, 1906) and *A. robustum* Utinomi, 1976, known from the North Pacific region.

---

[5] Everett, M. 2019. Personal commun. National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Boulevard East, Seattle, WA 98112.

1. *Alcyonium pacificum* Yamada, 1950

Description (Adapted from McFadden and Hochberg, 2003) Colonies are mushroom-shaped with a distinct capitulum and stalk. The capitulum is up to 4 cm in diameter and 1.5–2.0 cm in height, and slightly depressed in the center. A short, irregularly shaped stalk narrows basally to a cup-shaped attachment disc. Polyps are large, up to 1 cm in length, and are evenly distributed over the upper surface and margins of the capitulum only. The underside of the capitulum and stalk lacks polyps. Tentacles have 15–19 pinnules along each edge. Polyps are fully retractile, leaving slightly recessed apertures surrounded by eight triangular lobes (see photo F) formed by sclerites located in the most proximal region of the anthocodia. The distal region of the anthocodia lacks armature entirely.

Sclerites are white and distributed throughout the capitulum surface and in the coenenchyme of the capitulum and stalk. Sclerites are radiates that are often irregularly shaped and 0.09–0.11 mm in length. The color of the colonies in life is bright orange; creamy white in ethanol.

Remarks This species closely resembles *Discophyton rudyi* (Verseveldt and van Ofwegen, 1992), formerly *Alcyonium rudyi* Verseveldt and van Ofwegen, 1992. *Discophyton rudyi* has been documented from southern British Columbia to southern California and from the low intertidal zone to <10 m depth (McFadden and Hochberg, 2003; Verseveldt and van Ofwegen, 1992).

Distribution Uncommon. In Alaska – the Aleutian Islands from Adak Island to Attu Island (Fig. 5-3). Elsewhere – Northwest Pacific Ocean. The type locality is Akkeshi Bay, Hokkaido, Japan and this species has also been reported from shallow water near Matua Island (Kuril Islands, Russia) in the Sea of Okhotsk (Sanamyan and Sanamyan, 2020).

Habitat In Alaska – typically found in small but dense patches on bedrock at depths between 6 and 12 m. Elsewhere – the type specimens were collected in the low intertidal zone.

Photos A) A preserved (in ethanol) whole *A. pacificum* colony (SBMNH 145135), with polyps fully retracted, collected near Attu Island, western Aleutian

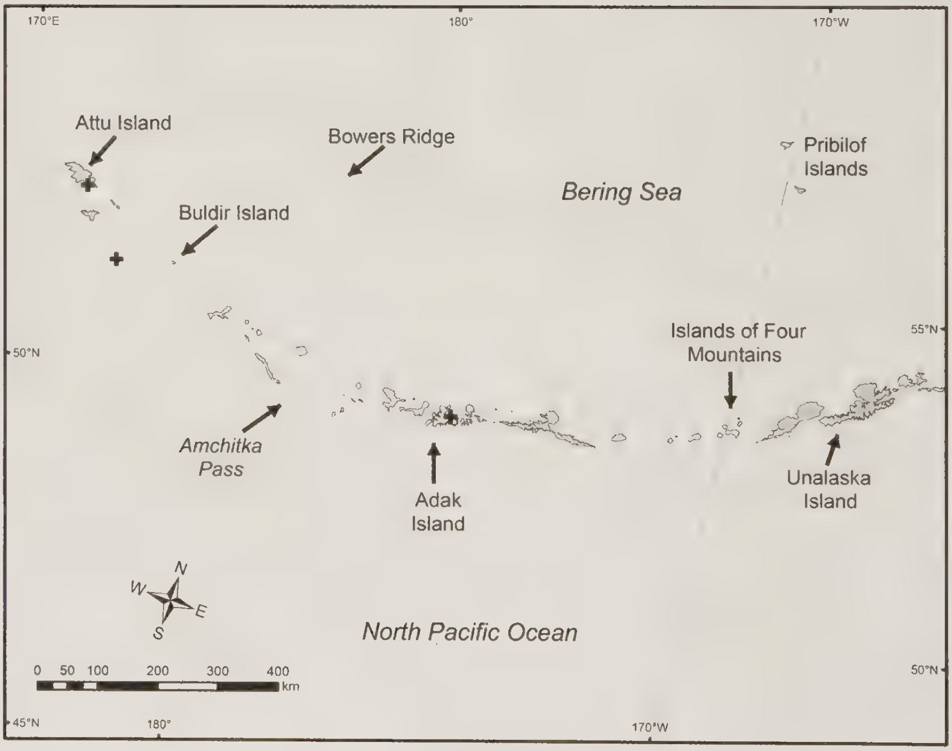
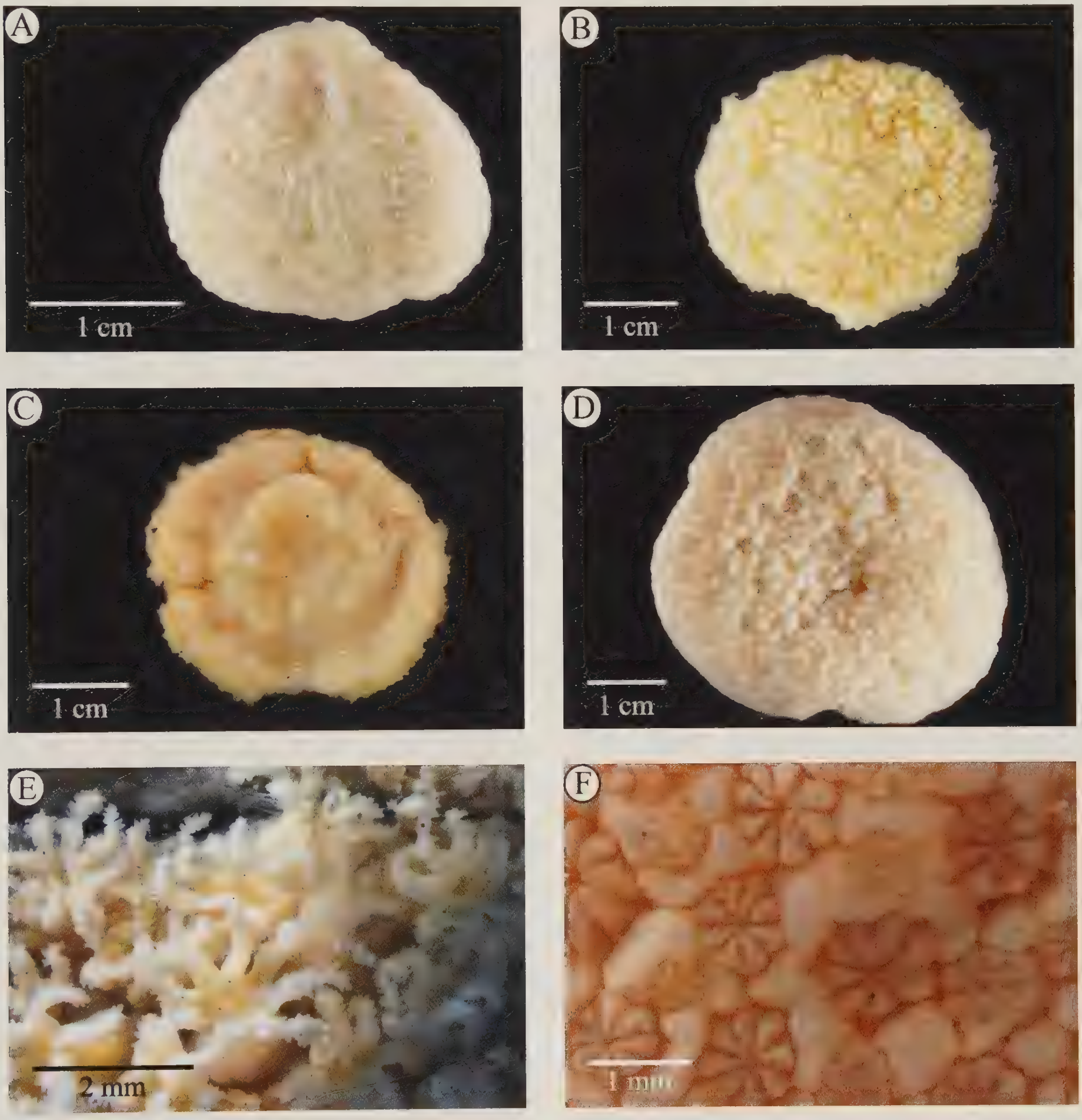


Figure 5-3

A map of the Aleutian Islands showing the distribution of *Alcyonium pacificum* (+) in Alaska waters.

Islands, at a depth of 6 to 12 m. B) A preserved (in ethanol) whole *A. pacificum* colony (SBMNH 145135), with polyps partially retracted, collected at the same location and depth as the specimen in photo A. C) The underside of the specimen in photo B showing the relatively short, irregularly shaped stalk. D) A preserved (in ethanol) whole *A. pacificum* colony (SBMNH 348114) collected near Adak Island, central Aleutian Islands, at a depth of 10 m. E) A close-up view of the same specimen in photo B. F) A close-up view of the same specimen in photo D. Photos E and F are courtesy of Daniel Geiger (Santa Barbara Museum of Natural History).



2. *Alcyonium* sp.

Description Colonies are mushroom-shaped with a polypiferous capitulum that is covered densely and uniformly with autozooids. The stalk is robust and may be relatively short or longer than the diameter of the capitulum. The stalk is up to 7 cm in height and the capitulum is up to 7 cm in diameter. On rare occasion two colonies growing in close proximity to each other will fuse together along the stalk (see photo E).

Color of the entire colony is a uniform bright to pale orange; lighter orange to yellow in ethanol.

Remarks The taxonomy of this group is unresolved so all specimens should be carefully re-examined. For the purpose of this guide, we separate this group from *Alcyonium pacificum* but the current status is *taxon inquirenda*. We are confident with the designation of *Alcyonium*, and specimens grouped here are clearly neither *Heteropolypus*, *Pseudoanthomastus*, nor *Anthomastus*. This group of specimens differs from all other Alcyoniidae known to occur in Alaska and undoubtedly represents either one or more undescribed species or one(s) not previously reported from the region.

Alcyonium is a very large genus with 58 valid species currently recognized worldwide (WoRMS Editorial Board, 2022). Most species are found in the Indo-Pacific region and the Atlantic Ocean including the Mediterranean Sea. Only three species are known from the North Pacific Ocean: 1) *A. pacificum* (discussed on page 90), 2) *Scleronephthya spiculosa* reported from the Sea of Okhotsk at 117 m, and 3) *A. robustum* reported from Japanese waters and inhabiting rocky areas at depths 120–150 m.

Several taxa may be represented in this group. Specimens partition into two distinct depth ranges (5–24 m and 103 m to about 600 m) and specimens with very short and noticeably long stalks. No records exist from depths between 24 and 103 m. We suggest that the short-stalked, shallow-water taxon (photos B, C, G, and H) may be *A. pacificum*. The long-stalked shallow-water taxon (photo A) and long-stalked deeper-water taxon (photos D, E, and F) likely represent additional taxa.

Two specimens (CAS 029138) from the Arctic Ocean (near Point Barrow) listed in Williams (2013) more closely conform to *Gersemia rubiformis* as presented in this guide so we list them there. However, Williams (2013) argues that these specimens likely represent an unidentified species of *Alcyonium*, clearly not the one(s) presented here. Williams (2013) furthermore questions the taxonomic validity of northeastern Pacific Ocean *G. rubiformis* specimens and urges that a taxonomic revision be undertaken with special regard to the species.

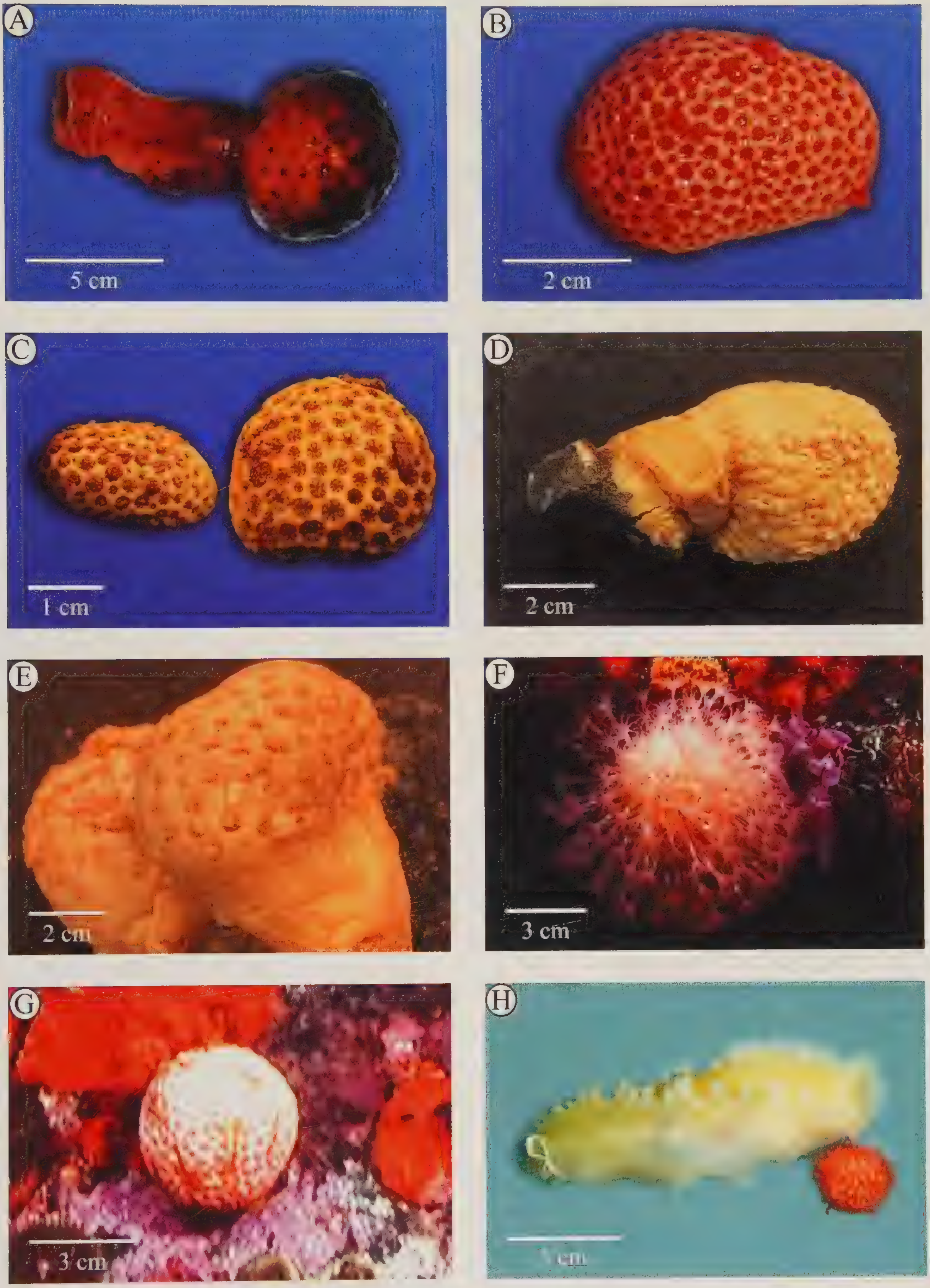
Preserved specimens of *Alcyonium* sp. can easily be mistaken for the pennatuloidean *Cavernularia vansyoci* Williams, 2005 without careful examination to confirm the absence of siphonozooids between the autozooids and to verify that the lower part of the colony is a holdfast and not a peduncle.

The nudibranch *Tritonia festiva* has been documented to prey on *Discophyton rudyi* along the west coast of North America (Verseveldt and van Ofwegen, 1992, personal observ. by J. Goddard on p. 173). We have made similar observations of *T. festiva* preying on *Alcyonium* sp. in the central Aleutian Islands (see photo H). Shallow-water specimens are often covered partially with a brown diatomaceous film and heavily secrete mucous upon collection.

Distribution Uncommon. In Alaska – the Aleutian Islands (Islands of Four Mountains to near Buldir Island) including Petrel Bank (Fig. 5-4). Elsewhere – unknown.

Habitat In Alaska – in shallow water (5–24 m depth), typically found in small but dense (>10 colonies/m^2) patches on bedrock. In deeper water (103–600 m depth), typically single or in low-density patches on bedrock, boulders, cobbles, and pebbles including fractured basalt.

Photos A) A fresh whole *Alcyonium* sp. colony (CAS # pending) collected near Bobrof Island in the central Aleutian Islands at a depth of 25 m. B) The capitulum of a fresh *Alcyonium* sp. specimen (CAS # pending) collected near Semisopochnoi Island, western Aleutian Islands, at a depth of 22 m. C) The dried capitulums of two *Alcyonium* sp. specimens (USNM 1482135) collected near Bobrof Island at a depth of 18 m. D) A preserved (in ethanol) whole *Alcyonium* sp. colony (USNM 100742) collected near the Islands of Four Mountains, eastern Aleutian Islands, at a depth of 150 m. E) Two conjoined whole *Alcyonium* sp. colonies (USNM 100802) preserved in ethanol, collected near Kiska Island, western Aleutian Islands, at a depth of 103 m. F) An *Alcyonium* sp. colony photographed north of Little Tanaga Island, central Aleutian Islands, at a depth of 25 m. G) An *Alcyonium* sp. colony photographed near Semisopochnoi Island at a depth of 26 m. H) A fresh whole *Alcyonium* sp. colony (USNM 1482136) collected on Petrel Bank at a depth of 160 m. The nudibranch (*T. festiva*) was preying on the coral.


A
5 cm
B
2 cm
C
1 cm
D
2 cm
E
2 cm
F
3 cm
G
3 cm
H
cm

2. *Alcyonium* sp. (continued)

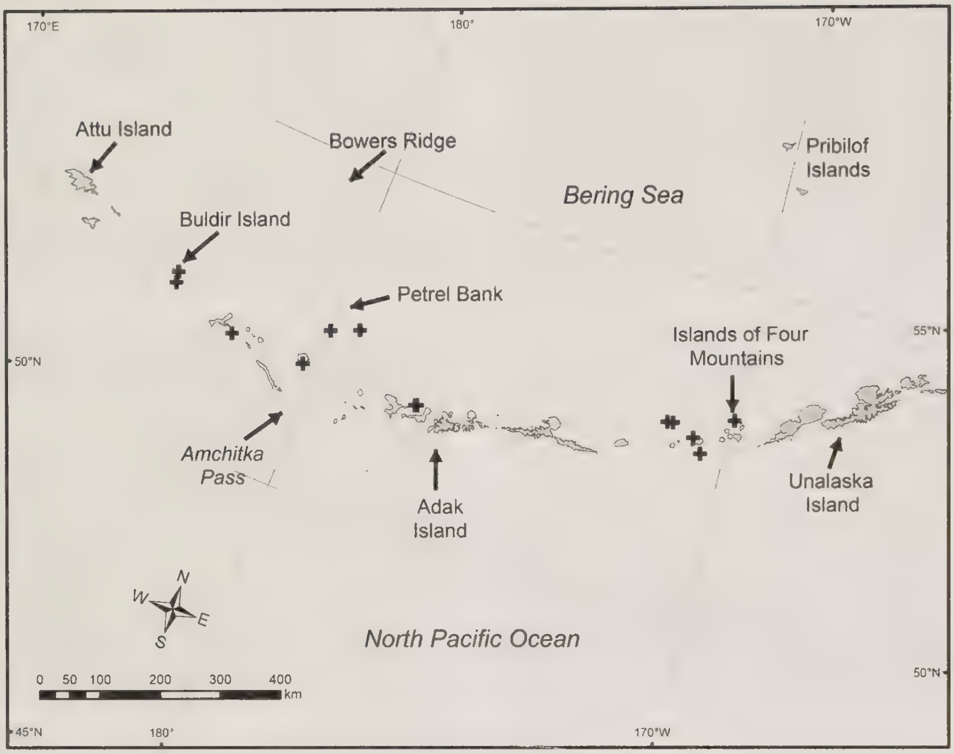

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 5-4

A map of the Aleutian Islands showing the distribution of *Alcyonium* sp. (+) in Alaska waters.

3. *Gersemia fruticosa* (Sars, 1860)

Description (Adapted from Verrill, 1922) Mature colonies consist of an obvious naked stalk branching irregularly near the base with numerous branches further dividing and subdividing into branchlets. Colonies are up to 40 cm in height and 25 cm in width when fully expanded. The terminal branchlets are blunt or capitate but mostly clavate in contracted specimens. Each branchlet may terminate in a few or many slender, elongated polyps, arising from slightly raised eight-lobed calyces. The polyps are so stiffened with small sclerites that they are nearly incapable of complete retraction within the calyces. The tentacles are long, somewhat swollen proximally, but tapered to slender tips; their larger pinnae are long and slender. The anthocodia terminates in eight small obtuse lobes or scallops corresponding to the tentacle bases. All sclerites are white in ethanol.

Colonies appear light orange or pinkish in situ and often the stalk is a lighter shade or even whitish. Specimens are darker orange or pink on deck, and orange to brown in ethanol.

Remarks This taxon is represented by a single confirmed specimen (USNM 60475, identified by F. M. Bayer, 1982), 21 additional specimens collected in deep water (1199–2248 m) and identified as *Gersemia* cf. *fruticosa*, and 13 colonies observed in situ in the central Aleutian Islands (Stone, 2014).

Verrill (1922) reports that this species is similar to *G. rubiformis* in modes of branching and general morphology but has less coenenchyme between the calyces and more sclerites in the anthocodial region and proximal part of the polyps. Additionally, the two species have vastly different depth distributions and our observations indicate that *G. fruticosa* has a more stalked rather than clustered morphometry.

Some of the specimens included here in this group (e.g., the one pictured in photos E and F on next page) are quite similar in appearance to *G. juliepackardae* Williams and Lundsten, 2009, known from the continental slope off northern Washington, central Oregon, and northern California including Monterey Canyon and several seamounts. This species attaches to hard substrate including hexactinellid skeleton at depths between 520 and 2034 m. The Alaska specimens listed here occupy similar habitats including depth range. Although the geographical ranges for the two species are separated by more than 1800 km, we recommend that the Alaska specimens be compared to specimens of *G. juliepackardae*.

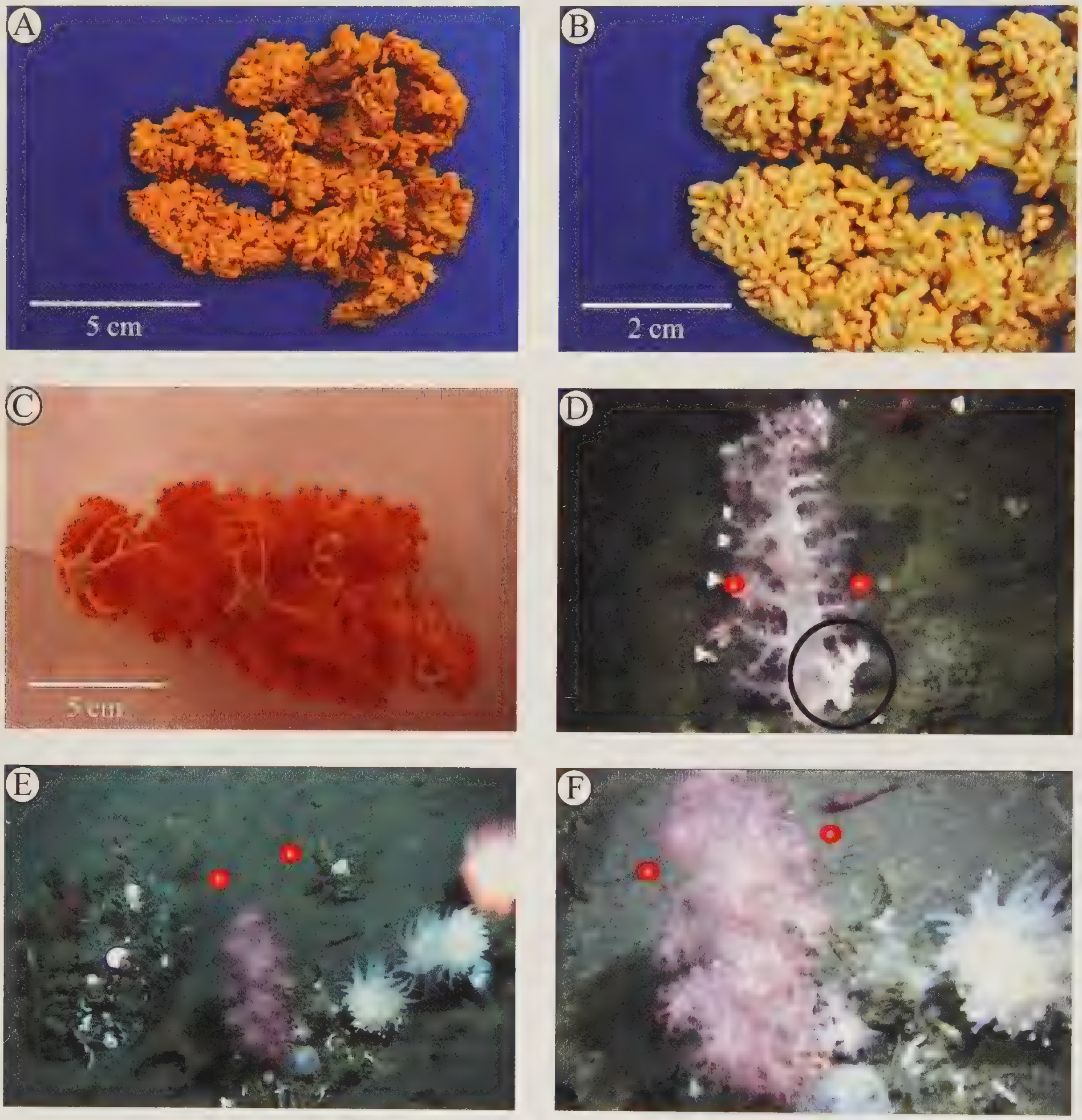
The cyclical rhythm of colony expansion and contraction has been studied in this species (Slephkova and Seravin, 1983; Seravin and Gudkov, 1990), and it occasionally harbors large numbers of ophiuroid commensals (see photo C on next page).

Distribution Uncommon. In Alaska – western Gulf of Alaska (Shumagin Bank) and the Aleutian Islands to Amchitka Pass (Fig. 5-5). Elsewhere – generally considered a North Atlantic Ocean species where it was originally described (Maritime Canada to Florida and Baffin Bay, Arctic Ocean) but also reported from the Kara Sea (Arctic Ocean), the Sea of Japan (Broch, 1932), and off the U.S. Pacific Coast.

Habitat In Alaska – always found singly but occasionally has daughter colonies near their base (see photo D on next page). Found on hard rock (boulders, cobbles, and pebbles) in areas of unconsolidated sediment at depths between 1005 and 2564 m. Elsewhere – eurybathic but principally a deep-water species: U.S. Pacific Coast (to 1946 m), Sea of Japan (70–100 m), Maritime Canada (91–361 m), mid-Atlantic U.S. (to 3506 m), Florida (to 770 m), and shallowest in the Kara Sea (Arctic Ocean) at 32–43 m.

Photos A) A preserved (in ethanol) whole *G. fruticosa* colony (USNM 60475) collected on Shumagin Bank, western Gulf of Alaska, at a depth of 1143 m. B) A close-up view of the same specimen in photo A. C) A preserved (in ethanol) whole *G. fruticosa* colony (CAS 234586) collected in northern Amchitka Pass at a depth of 2248 m. The base of the colony is on the left. D) The same colony in photo C, only partly expanded, prior to collection. A daughter colony is present immediately to the right of the collected specimen (black circle). E) A *G. fruticosa* colony (CAS 234577) in situ northwest of Kanaga Island, central Aleutian Islands, at a depth of 1199 m. The colony is fully expanded. F) A close-up view of the same colony in photo E. The distance between the red laser marks in photos D–F is 10 cm.

3. *Gersemia fruticosa* (Sars, 1860) (continued)


A
5 cm
B
2 cm
C
5 cm
D
E
F

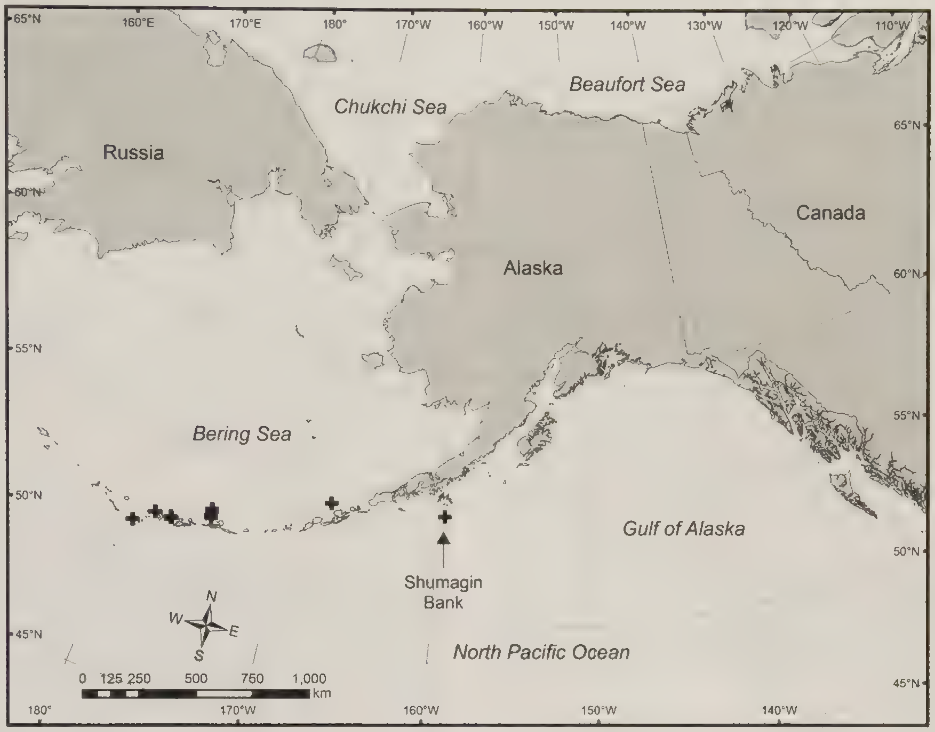

Russia
Chukchi Sea
Beaufort Sea
Alaska
Canada
Bering Sea
Gulf of Alaska
North Pacific Ocean
Shumagin Bank
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 5-5

A map of the North Pacific Ocean showing the distribution of *Gersemia fruticosa* (+) in Alaska waters.

4. *Gersemia lambi* Williams, 2013

Description (Adapted from Williams, 2013) Colonies are composed of dense concentrations of autozooids distributed in isolated clusters on several short lobes that emanate from a very short stalk and asymmetrical holdfast. Each cluster usually contains 15–30 polyps. Polyps are erect and curve upward from their bases. Polyps are monomorphic, non-retractile, tubular, and relatively large (4–7 mm in height and 1.5–2 mm in width). The width of the polyps is greatest at the distal extremity.

Most coenenchymal sclerites of the polyps are sharply tuberculated radiates (0.03–0.12 mm in length), and most of those in the stalk are variably ornamented radiates and modified radiates (0.03–0.12 mm in length). Polyp wall sclerites are abundant, uniformly and densely distributed, and most are variably shaped radiates and rods with a few irregularly shaped elongate forms and crosses (0.03–0.13 mm in length). Tentacular sclerites are densely and uniformly distributed and mostly radiates and rods, although a few club-shaped or torch-like forms are also present.

Colonies are pinkish-orange in life and creamy white to pale orange when preserved in ethanol.

Distribution Uncommon but reportedly abundant locally (Fig. 5-6). In Alaska – known only from observations made in situ between Cape Ommaney at the southern tip of Baranof Island and Cross Sound and Icy Strait north of Chichagof Island, eastern Gulf of Alaska (McDaniel[6]). Elsewhere – known from three locations in central to northern British Columbia, including near Langara Island in southern Dixon Entrance, near the border with Southeast Alaska.

Habitat In Alaska – occurs in dense patches from the shallow subtidal zone to 30 m on bedrock and in areas of strong current and wave surge. Elsewhere – shallow subtidal zone (9–20 m depth) on bedrock and in areas of strong current and wave surge.

Photos A) A lateral view of a preserved (in ethanol) whole *Gersemia lambi* colony (CAS 171940; paratype) collected near Langara Island, Haida Gwaii, in Dixon Entrance, northern British Columbia, at a depth of 12

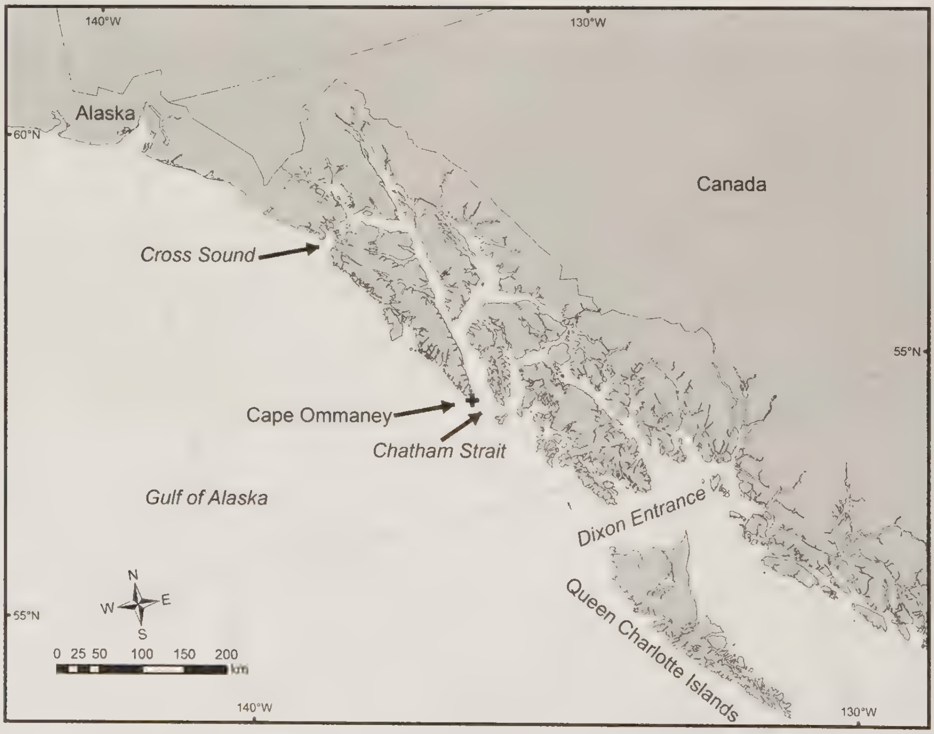


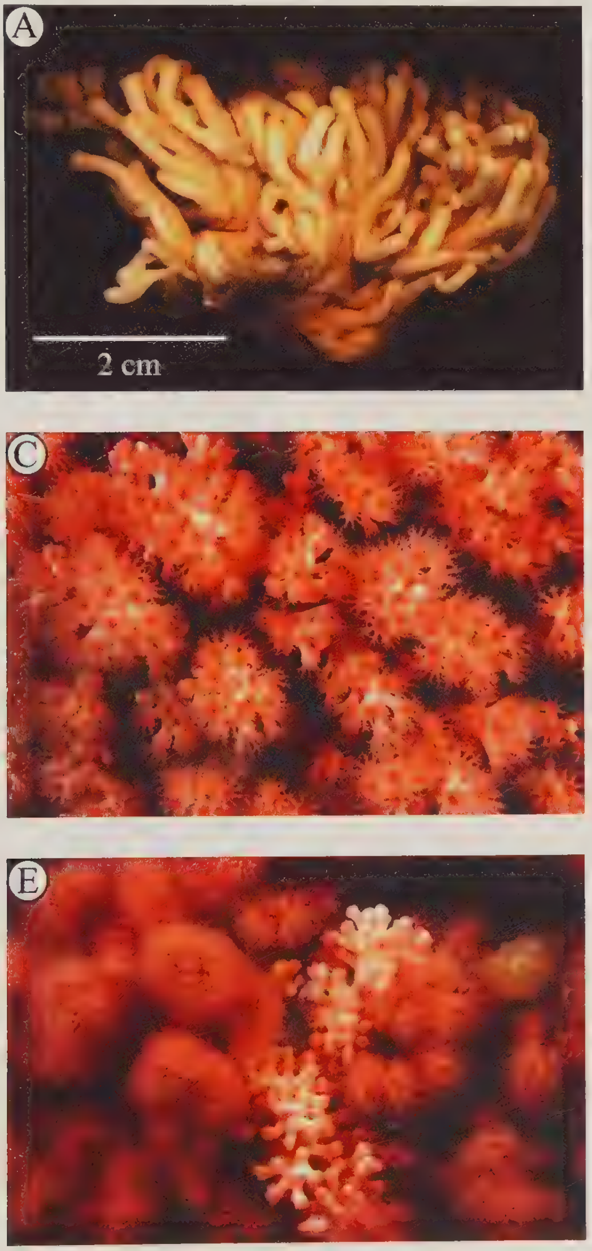
Figure 5-6

A map of the eastern Gulf of Alaska showing the distribution of *Gersemia lambi* (+) in Alaska waters.

---

[6] McDaniel, N. 2019. Personal commun. McDaniel Marine Surveys, 354 West 35th Ave., Vancouver, BC, Canada V6N 2N5.

m. B) A view from the top of the preserved (in ethanol) *G. lambi* holotype (CAS 171939; whole colony) collected near Langara Island, Haida Gwaii, in Dixon Entrance, northern British Columbia, at a depth of 12 m. C) *Gersemia lambi* colonies with polyps fully extended, photographed near the type collection sites. The photo is courtesy of Marc Chamberlain. D) *Gersemia lambi* colonies with polyps fully contracted. The colonies were photographed near the Kerouard Islands, Haida Gwaii, central British Columbia, at a depth of 6 m. E) *Gersemia lambi* colonies with polyps fully contracted and surrounded by a bed of what appears to be *G. rubiformis* with much smaller polyps fully extended. The colonies were photographed near the Kerouard Islands, Haida Gwaii, central British Columbia, at a depth of 6 m. Photos D and E are courtesy of Neil McDaniel. All photos are reproductions of those provided in Williams (2013).



5. *Gersemia rubiformis* (Ehrenberg, 1834)

Description (Adapted from Verrill, 1922) Dried (contracted) specimens consist of rounded or ovate clusters of rather hard, short, thick branches or lobes, convex externally, and attached to the main stalk by short stems, smaller than the enlarged ends. The main stem may be very short or somewhat elongated and without branches or calyces near the base, which usually spreads out in a thin expansion for attachment. The lower part of the stem and holdfast often lack the surface layer of red sclerites that occurs elsewhere in the colony. The surface of the branches bears polyps and is covered with a thin but firm layer of compact minute rough sclerites (red to pale red in color) which give the surface a finely granular appearance and the corallum a red, pinkish, or light to bright orange color. Sclerites include spindles (irregular, short, lobed, or warty), double spindles, ellipsoids, and a few elongated rough forms. Contracted specimens resemble raspberries or strawberries and bear the common name "sea raspberries" or "sea strawberries." They typically range to about 6 cm in diameter.

The polyps in preserved specimens are usually completely contracted, but not always revealing a conical anthocodia with eight feeble double rows of minute and elongated, rough, fusiform sclerites arranged *en chevron*. The extended mature polyps are much smaller than those of *G. lambi*, about 2.0–2.5 mm in length and 0.7 mm in width; tentacles are usually without sclerites.

Color of colonies in life and in ethanol is uniform shades of orange and red.

Remarks This species is gonochoric and broods its larvae (Verrill, 1922; Nørrevang, 1973). The effects of simulated fishery disturbance on the reproduction and regenerative capability of this species have been studied in the laboratory (Henry et al., 2003). *Gersemia rubiformis* includes 51 specimens definitively identified and 15 additional specimens identified as *G.* cf. *rubiformis*.

Distribution Locally common and widespread. This species is the northernmost coral in the Pacific Ocean. In Alaska – generally a northern taxon, particularly common and abundant on the broad continental shelf of the eastern Bering Sea, Chukchi Sea, and Beaufort Sea. Also present in the Gulf of Alaska and the Aleutian Islands from Unimak Pass to southern Amchitka Pass (Fig. 5-7). Elsewhere – nearly circumpolar with a geographical range similar to *G. fruticosa*: off the Kamchatka Peninsula (Russia) including the Sea of Okhotsk, the Pacific Coast of North America (British Columbia to northern California), Arctic Ocean (Kara Sea to Baffin Bay and Greenland), and the Atlantic Coast of North America (Maritime Canada to North Carolina).

Habitat In Alaska – occurs in dense patches on bedrock in shallow water but singly or in small clusters on cobbles and pebbles in areas of unconsolidated sediment in the deeper part of its range. Total depth range is 3–90 m. Elsewhere – reported on cobbles, pebbles, and shell at depths between 1 and 457 m.

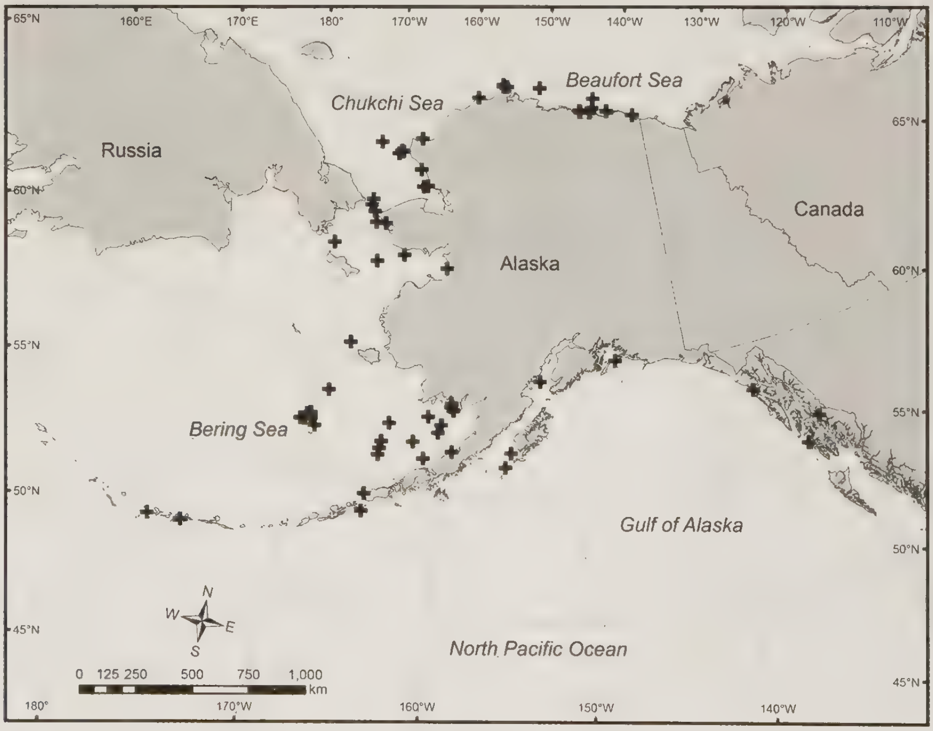
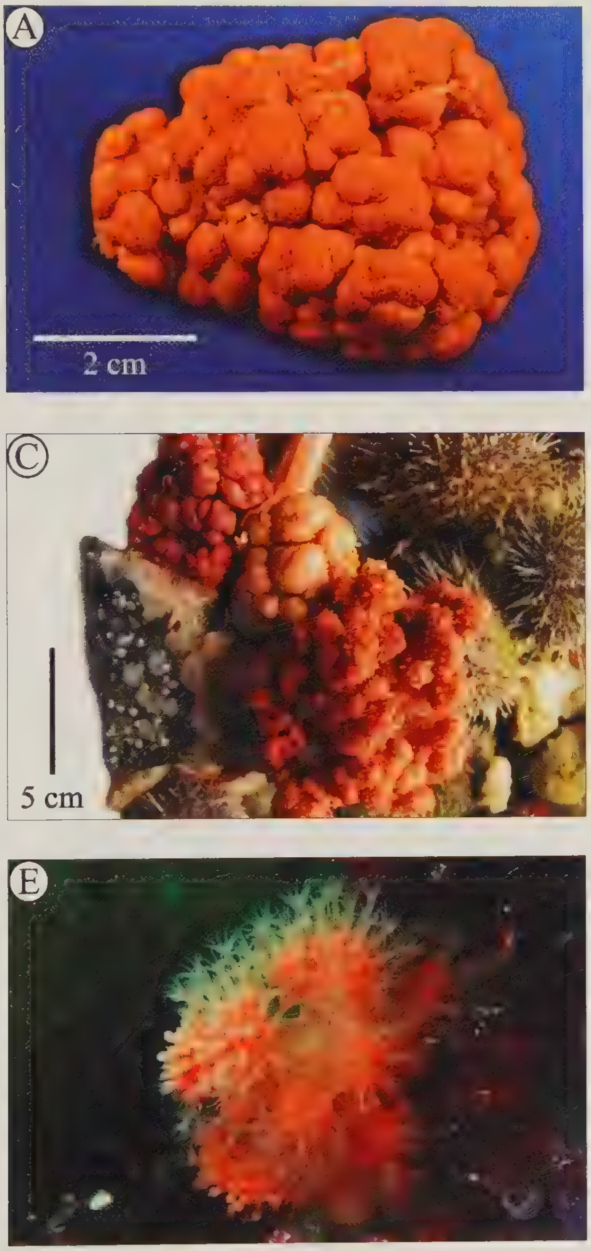


Figure 5-7

A map of the North Pacific Ocean showing the distribution of *Gersemia rubiformis* (+) in Alaska waters.

Photos A) A preserved (in ethanol) whole *G. rubiformis* colony (USNM 1482143) collected near Adak Island, central Aleutian Islands, at a depth of 18 m. B) A preserved (in ethanol) whole *G. rubiformis* colony (USNM 1482144) collected near St. Paul Island in the eastern Bering Sea at a depth of 8 m. C) *Gersemia rubiformis* specimens collected in the Chukchi Sea at a depth of approximately 40 m. D) A *G. rubiformis* colony photographed near Cape Ulitka, Noyes Island, in the eastern Gulf of Alaska at a depth of about 15 m. E) A *G. rubiformis* colony photographed at the same location and depth as the specimen in photo D. Photos D and E are courtesy of D. K. Harris (Alaska Department of Fish and Game).



6. *Gersemia* sp.

Description Colonies are dentritic to slightly bushy with branches emanating above the base and on all sides. Branches may terminate in up to five large, brightly colored polyps (approximately 60 polyps total). The largest contracted specimen measures 18 mm in height and 16 mm in width, but the same specimen measured in situ fully expanded is up to 10 cm in height and 7 cm in width. The color of the main colony and base in situ is creamy white and the distal end of branches and polyps is orange-red to pink. In ethanol, most of the colony is reddish-orange with a creamy basal plate.

Remarks The species is known from only two collected specimens and several video observations of similar specimens made on the same and a nearby seamount. At the collection site, seven specimens were clustered together, each separated by 2–10 cm; the two largest specimens were collected.

Distribution Rare. In Alaska – Pratt and Giacomini Seamounts in the Gulf of Alaska Seamount Province (Fig. 5-8). Elsewhere – unknown.

Habitat In Alaska – occurs singly or in clusters up to seven colonies on bedrock and fractured bedrock and at depths between 897 and 1095 m.

Photos A) A preserved (in ethanol) whole *Gersemia* sp. colony (USNM 1075807) collected on Pratt Seamount at a depth of 1092 m. B) The opposite side view of the same specimen in photo A. C) Mostly contracted *Gersemia* sp. colonies in situ on Pratt Seamount at 1092 m depth. Specimens in photos A and B are visible in the center of the photo. D) A *Gersemia* sp. colony (fully expanded) observed on Pratt Seamount at a depth of 1095 m. The distance between the red laser marks in photos C and D is 10 cm. E) A close-up view of the same colony in photo D. F) A zoomed-in view of the same colony in photo D.

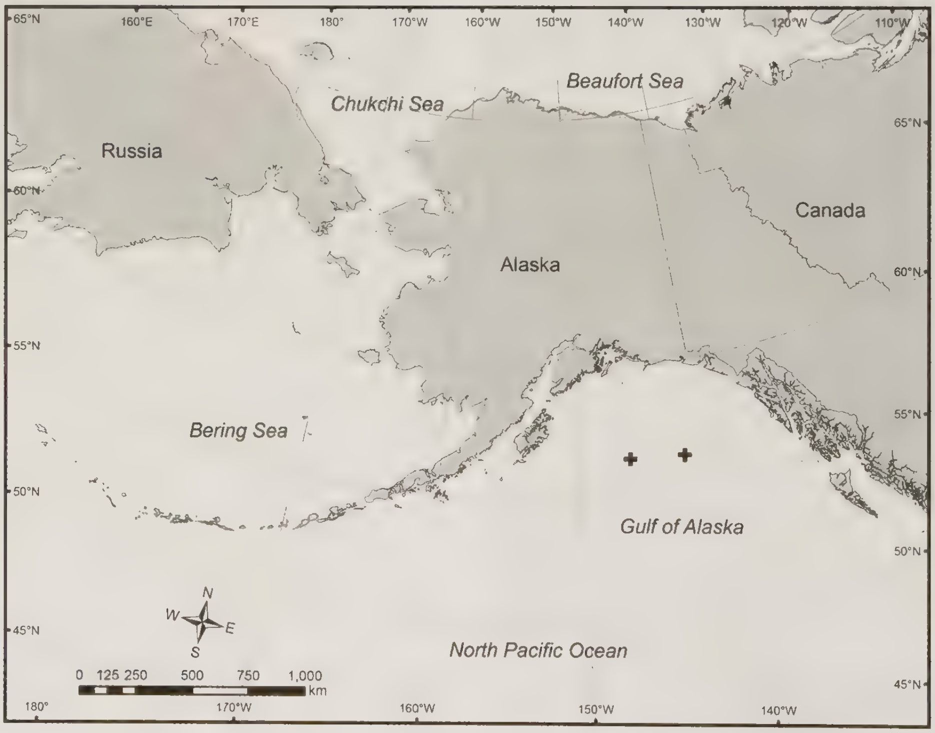
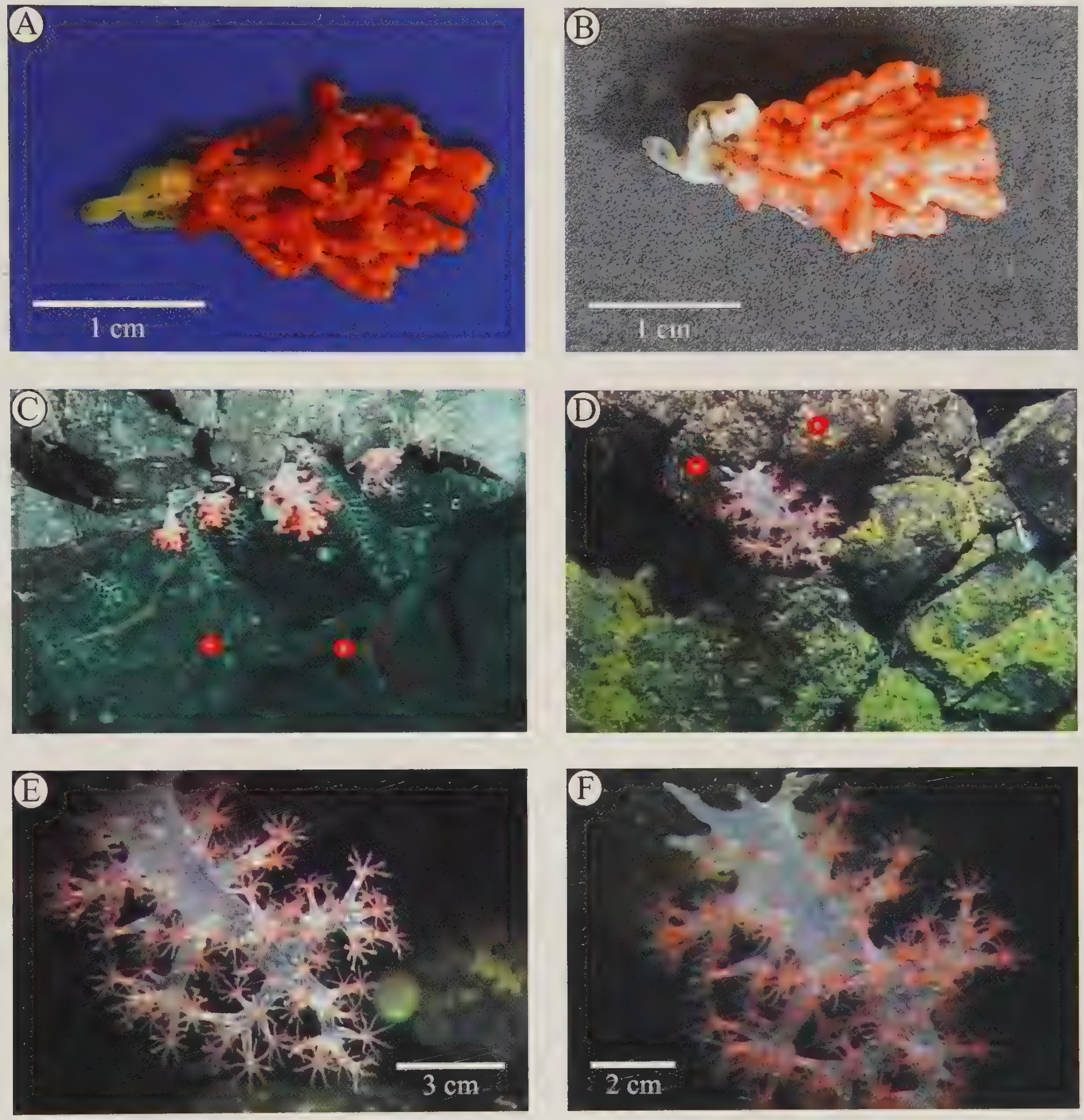

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
Canada
Alaska
60°N
55°N
50°N
45°N
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W

Figure 5-8

A map of the North Pacific Ocean showing the distribution of *Gersemia* sp. (+) in Alaska waters.


A
1 cm
B
1 cm
C
D
E
3 cm
F
2 cm

Family Clavulariidae

(Adapted from Verrill, 1922 and McFadden et al., 2022) Clavulariids are stoloniferous octocorals without a skeletal axis and with polyps connected basally by ribbon-like stolons. Polyps are monomorphic; anthocodiae are retractile into clavate calyces that may be extraordinarily tall. Pinnules may be free or fused, forming broad blade-like expansions of the tentacle. The prominent calyces are packed with sclerites (mostly warty spindles), and the polyps and anthocodiae are quite spiculose (Verrill, 1922). Colonies are generally small and consist of cylindrical or bluntly conical polyps, usually joined only at their bases by reticulating stolons which may further coalesce into thin membranous expansions.

Of the three known genera of Clavulariidae, only *Clavularia* (four species) is found in Alaska. Most taxa are rare or uncommon and have a limited distribution in the western Gulf of Alaska, Pratt Seamount in the Gulf of Alaska Seamount Province, the Aleutian Islands, and the eastern Bering Sea as far north as Zhemchug Canyon (Fig. 6-1). They are eurybathic fauna occupying depths between 82 and 3277 m. Aside from growing directly on hard rock (bedrock, boulders, cobbles, pebbles, and siltstone), they often encrust a wide array of biotic substrates including the skeletons of octocorals (keratoisidids, gorgoniids, and paramuriceidids), antipatharians, stylasterids, hexactinellid sponge skeletons, mollusk shells, and bryozoans.

All clavulariid specimens collected in stock assessment and research surveys should be retained for taxonomic studies, including advanced molecular DNA techniques.

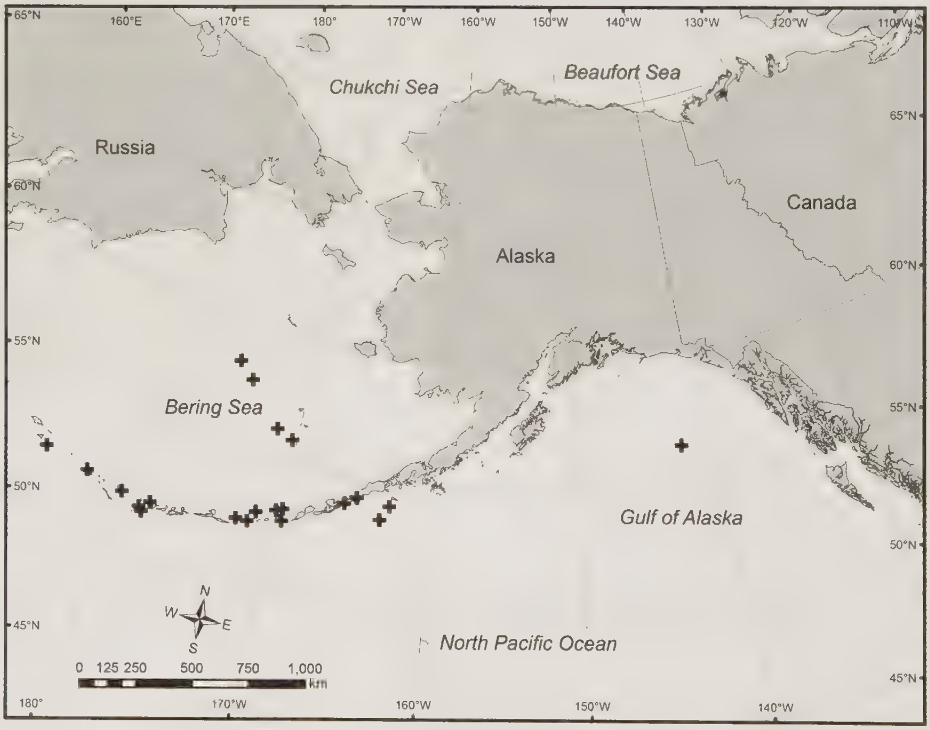

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
Bering Sea
55°N
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 6-1

A map of the North Pacific Ocean showing the distribution of corals in the family Clavulariidae (**+**) in Alaska waters.

1. *Clavularia armata* Thomson, 1927

Description (Adapted from Thomson, 1927) The most peculiar characteristic of this species is the extreme spiculation of the entire colony, including the stolon and calyces. This is due to the projection of the tips of the spindles, which, in general, are directed upwards and outwards from the calyx. Abundant sclerites at the upper part of the calyx are arranged in eight groups, each of which exhibits roughly an *en chevron* arrangement, but progresses to distinct protrusions. Sclerites are almost entirely spindles (0.35–0.40 mm in length by 0.04–0.06 mm in diameter) and a few distinct crosses (0.23 mm in length). The largest spindles (0.43–0.46 mm in length by 0.07–0.09 mm in diameter) bear a few warts. The type specimen has polyps that are about 4 mm in length and only partially retracted into the calyx. This specimen was growing on the bare skeletal section of a live bamboo coral (*Keratoisis* sp.) and was described as slightly bluish in color, presumably due to the presence of dark mineral particles inside the polyps.

This species is known in Alaska from only two collected specimens; one had mostly overgrown the skeletal stalk of a hexactinellid sponge (*Crateromorpha* sp.) that was attached to a boulder (photos A–E on next page) and the other had completely overgrown a *Bathygorgia profunda* colony that was attached to fractured basalt. Also, two additional colonies were observed together on unknown hexactinellid skeletons growing on another boulder nearby. The largest collected specimen has a relatively thick coenenchyme densely populated with large polyps (18 mm in length) that taper from the base (approximately 6 mm) to the top (4 mm). The tentacles are quite long (up to 12 mm in length) and during collection of the specimen the polyps were very slow to retract. The color of the coenenchyme is a uniform, light orange in life; the polyps are a lighter orange, almost translucent along their length.

Distribution Rare. In Alaska – known only from Pratt Seamount in the Gulf of Alaska Seamount Province (Fig. 6-2). Elsewhere – the type specimens were collected near the Azores (Portugal) in the North Atlantic Ocean.

Habitat In Alaska – grows on hexactinellid and bamboo coral skeletons that are attached to boulders at depths between 2667 and 2730 m. Elsewhere – grows

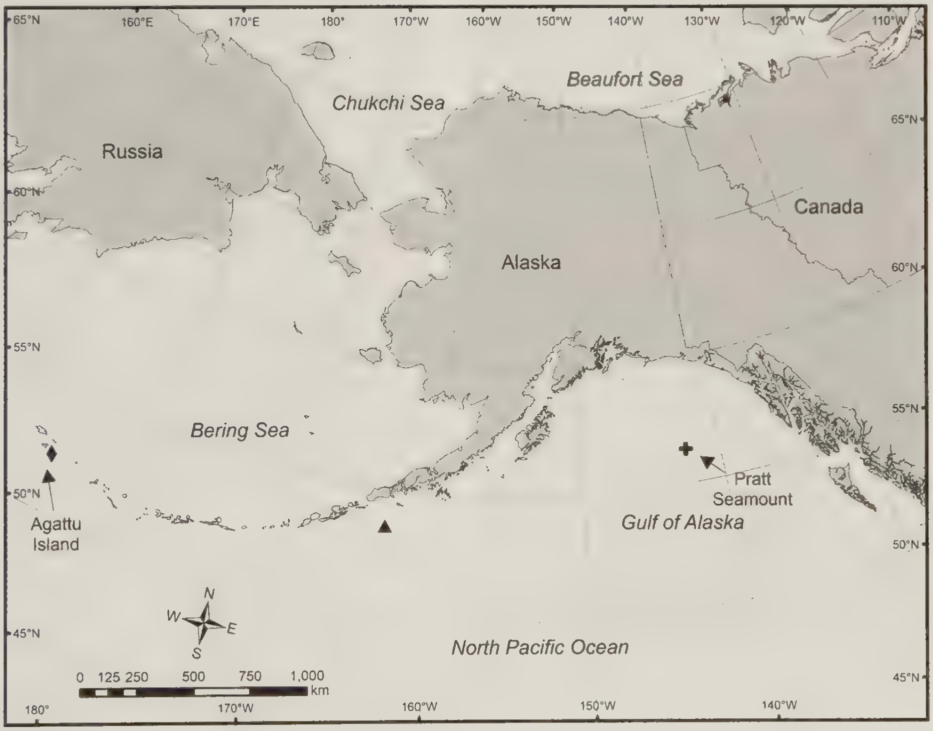
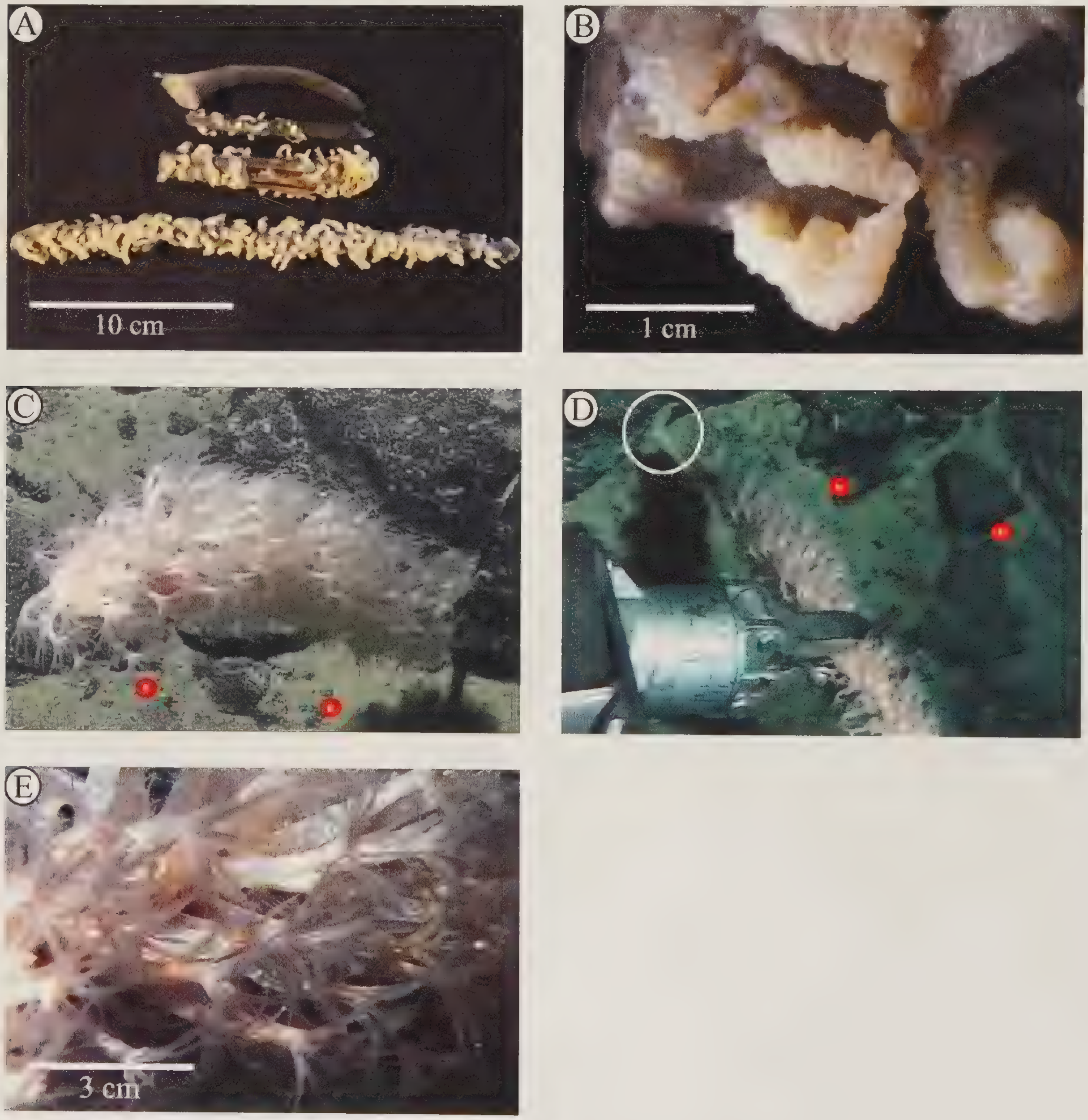


Figure 6-2

A map of the North Pacific Ocean showing the distribution of *Clavularia armata* (+), *C. eburnea* (♦), and *C. rigida* (▲) in Alaska waters.

on the skeleton of bamboo corals (*Keratoisis* sp.) in areas of sand and limestone at depths between 1153 and 1600 m.

Photos A) A preserved (in ethanol) fragmented but whole *Clavularia armata* colony (USNM 1076621) collected on Pratt Seamount in the Gulf of Alaska Seamount Province at a depth of 2689 m. The colony has completely overgrown the attached stalk (relic) of a hexactinellid sponge (*Crateromorpha* sp.). B) A close-up view of the same colony in photo A. C) The same colony in photo A in situ. D) The same colony in photo A during collection. The holdfast of the sponge is indicated by the white circle. E) A close-up view of the same colony with fully extended polyps. The distance between the red laser marks in photos C and D is 10 cm.



2. *Clavularia eburnea* Kükenthal, 1906

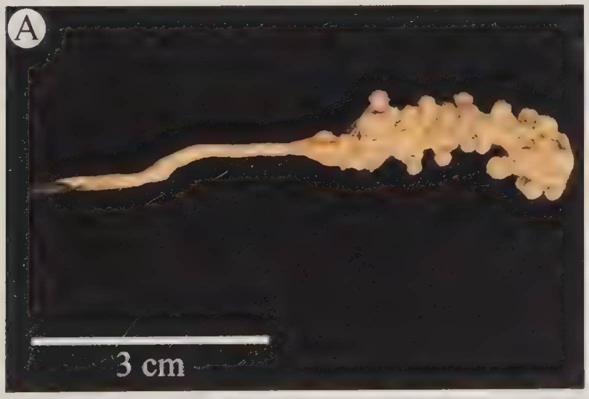
Description (Adapted from the original description by Kükenthal, 1906) Numerous polyps originate from a membranous base that thickens in places at acute angles. Polyps are large (up to 12 mm in length and 3 mm in width), at least partly retractile, and each has a calyx half the height of the total polyp. The calyx has a sharp wall with eight distinct longitudinal furrows; the upper, retractile section of the polyp is more delicately walled, cup-shaped, and supports stout tentacles up to 3 mm in length with 10–11 thick pinnules on each side, the middle of which are the longest. The pinnules contain rod-shaped, wide-thorned sclerites that are 0.09 mm in length; they are slightly larger in the tentacle axis and arranged in double rows that converge downwards. The upper polyp section contains longitudinal spindles up to 0.25 mm in length, as well as clubs and more irregular bodies, all irregularly adorned with large, rounded thorns. The calyx wall contains many spiked lobes 0.13 mm in length that are strongly constricted in the middle. The basal section of the polyp and the coenenchyme contain smaller (0.07 mm in length), irregular-shaped sclerites. The color of the specimen was a uniform ivory white.

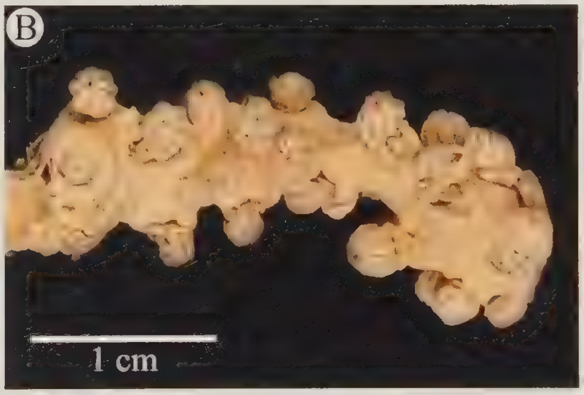
The only record of this species in Alaska is a specimen (USNM 30106; photos A and B below) collected by the U.S. Fisheries Steamer *Albatross* in the western Aleutian Islands and identified by Nutting (1912). Nutting (1912) noted that the specimen was attached to an alcyonarian stem and had small polyps (7 mm in length), but otherwise conformed to the description for the type specimen. The specimen has clearly and completely overgrown an octocoral skeleton, possibly *Calcigorgia japonica* Dautova, 2007, and without very careful examination would likely have been mistaken as the latter species. The specimen appears to have a very thick coenenchyme and the color in ethanol is very pale orange.

Distribution Rare. In Alaska – known only from a single specimen collected southeast of Agattu Island in the western Aleutian Islands (Fig. 6-2). Elsewhere – the type specimen was collected in the Sea of Japan.

Habitat In Alaska – grows on attached octocoral skeleton at depths near 715 m. Elsewhere – the type specimen was collected at a depth between 600 and 1200 m.

Photos A) A preserved (in ethanol) whole *Clavularia eburnea* colony (USNM 30106) collected southeast of Agattu Island, western Aleutian Islands at a depth of 715 m. The specimen has completely overgrown an octocoral (likely *Calcigorgia* sp.). B) A close-up view of the same colony in photo A.





3. *Clavularia rigida* Broch, 1935

Description (Adapted from the original description by Broch, 1935) Colonies form a membranous crust-like stolon that gives rise to relatively large polyps (up to about 8 mm in length) that are completely retractile into cylindrical or weakly club-shaped calyces. Calyces reach 2.3 mm in diameter near the slightly wider top and are quite rigid due to a dense concentration of sclerites. The polyps are packed close together. The calyx wall has eight weakly protruding longitudinal bulges, which are reinforced in younger polyps with eight double rows of densely lying, upwardly converging sclerites. In older individuals, the double rows are better described as eight dense lines of sclerites that are arranged almost completely parallel. The closed calyx resembles an eight-pointed star-shaped feature above the retracted head.

A crown of well-developed sclerites adorns the polyp head, which is sharply bordered and separated from the calyx by a wide area without sclerites. A basal wreath of horizontally lying sclerites, from which rise eight short double rows, forms the crown. The tentacle stem contains only densely packed sclerites. The stolon plate contains densely packed sclerites, which are irregularly curved, quite slender (0.5–0.7 mm in length), spindle- or rod-shaped, and heavily thorned. The densely packed sclerites of the calyx are relatively large (1.40–1.56 mm in length); the smaller and medium-sized sclerites are slender and heavily thorned, sometimes slightly curved spindles. The larger ones are basic spindles that are also heavily thorned, but otherwise irregular variably sized wart-like or thorny spurs, often with forked ends. The sclerites of the crown of the polyp head are 0.34–0.55 mm in length and are otherwise similar to those of the stolon plate, except more weakly curved. The tentacle sclerites are short, broad, oval- to rod-shaped with rounded ends; heavily armored with small thorns. The tentacles are quite small (0.15–0.34 mm in length).

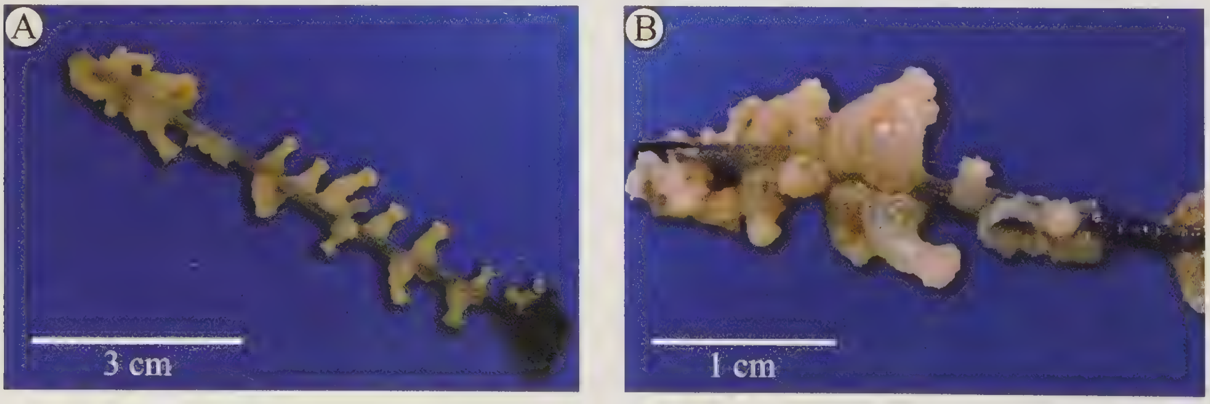
The only record of this species in Alaska is a specimen (USNM 1081183; photos A and B below) collected on the deep abyssal plain near the Aleutian Trench and identified by S. D. Cairns in 2005. The specimen has completely overgrown the stem of an antipatharian skeleton, probably *Bathypathes tiburonae*, which are fairly common in that area and at that depth. The specimen appears to have a very thin coenenchyme with irregularly situated polyps, and the color in ethanol is a very pale orange.

Remarks Close examination of the preserved specimen revealed that there was actually a second very small (only three polyps) colony growing on the holdfast.

Distribution Rare. In Alaska – known only from a single specimen collected on the deep island arc slope south of Davidson Bank, eastern Aleutian Islands (Fig. 6-2). Elsewhere – the type specimen was collected from the Sea of Okhotsk, Russia.

Habitat In Alaska – the specimen was growing on the unpinnulated lower (7 cm) stalk of a black coral, likely *Bathypathes tiburonae*, that occurs in the same area and depth range. The black coral was growing on siltstone at a depth of 3277 m. Elsewhere – the type specimen was collected at a depth of 1076 m.

Photos A) A preserved (in ethanol) whole *Clavularia rigida* colony (USNM 1081183) collected south of Unimak Island, eastern Aleutian Islands, at a depth of 3277 m. B) A close-up view of the same specimen in photo A.



4. *Clavularia* sp. A

Description Colonies form irregularly shaped mats up to 15 cm in length and width. Polyps are randomly distributed throughout the stolon in distinct clusters and are up to 8 mm in height when fully expanded. Calyces are almost perfectly cylindrical, short, and stout (up to 4 mm in height and 4 mm in diameter). Polyps appear to be at least partly non-retractile, and the collarets in fresh specimens are about the same length and diameter as the calyx. The tentacles and pinnules are short and stout. The sclerites have not yet been described for this taxon. The coenenchyme is relatively thick and the color in life is a uniform orange with slightly darker polyps; the color fades somewhat in dried specimens and turns a golden brown in ethanol.

Remarks Our observations of this species growing in heavily disturbed habitats in the central Aleutian Islands (see photo E on next page) indicate that it might be a pioneer species with a relatively fast growth rate. It is also an opportunistic species, as are other Alaska stoloniferans, in that they settle and grow on both abiotic and biotic substrates. Most of our observations indicate that these corals grow on the skeletons or non-living tissue of other marine life but there is some evidence (see photos A and B on next page) that they may also be epizoic, similar to zoantharians that settle and grow on live animals and kill them in the process.

The coenenchyme of this species is composed almost entirely of high-magnesium calcite (8.3 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data). Associated microfauna include pleustid amphipods (Watling and Stone[7]).

Distribution Locally common. In Alaska – western Gulf of Alaska (south of Sanak Island), Aleutian Islands (near Unalaska Island to southeast of Agattu Island), and Pribilof Canyon to north of Zhemchug Canyon in the eastern Bering Sea (Fig. 6-3). This species is particularly abundant on Amchixtam Chaxsxii in northern

---

[7] Watling, L., and R. P. Stone. 2007. Appendix E. Macro-fauna associated with deep corals in the Aleutian Islands. *In* Deep sea coral distribution and habitat in the Aleutian Archipelago (J. Heifetz, D. Woodby, J. Reynolds, and R. P. Stone, eds.), p. 295–304. North Pacific Res. Board Final Rep. 304. [Available from https://projects.nprb.org/#metadata/ebf15fb7-dc07-406a-bb74-8dd3c978a1e0/project]

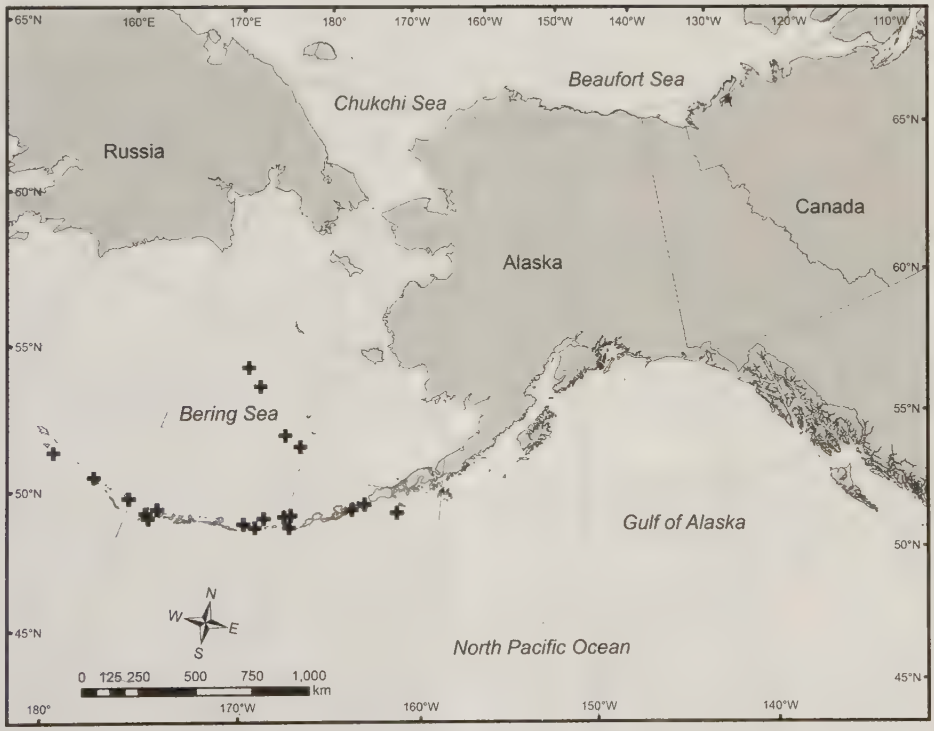


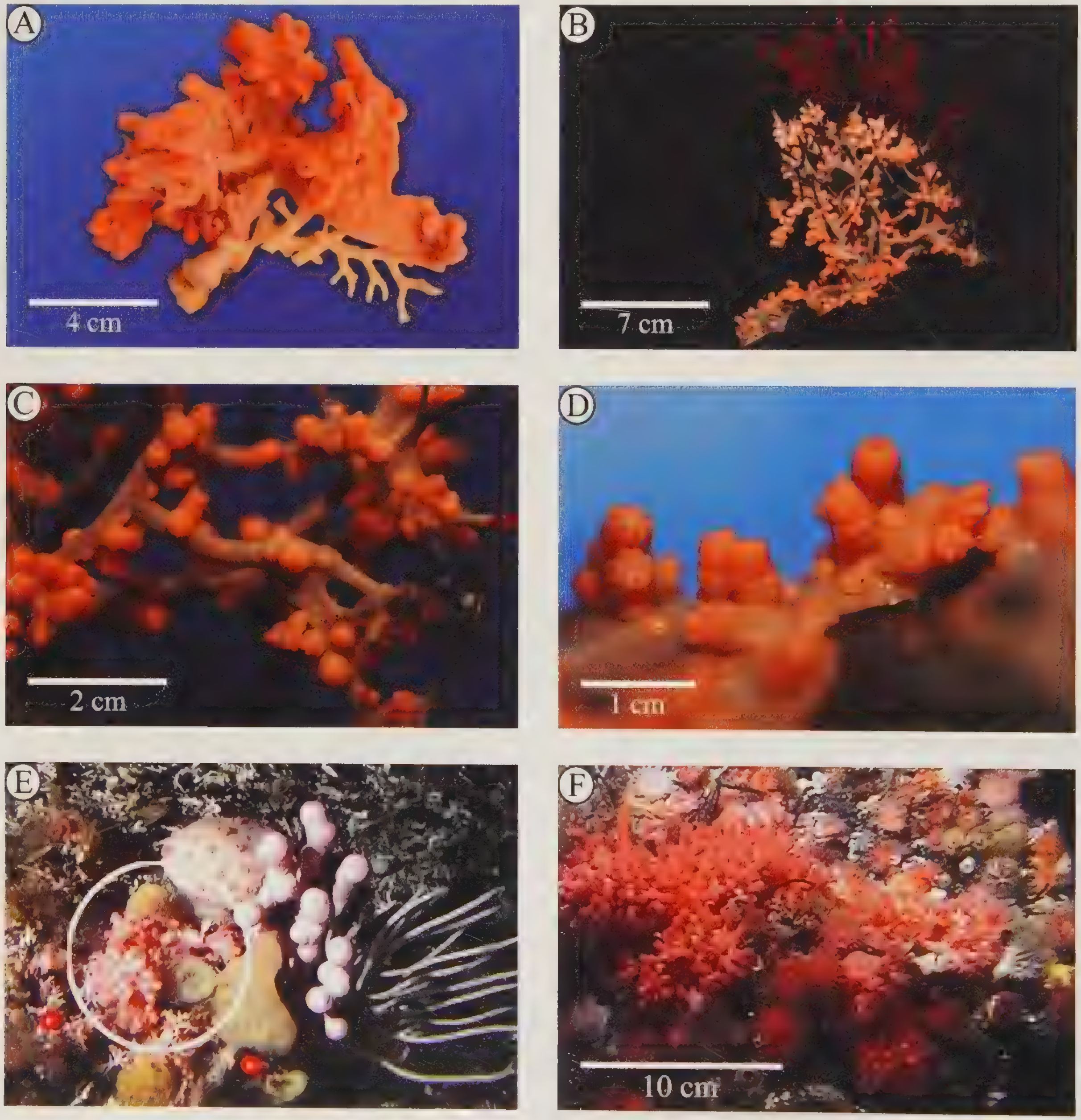
Figure 6-3

A map of the North Pacific Ocean showing the distribution of *Clavularia* sp. A (+) in Alaska waters.

Amchitka Pass (central Aleutian Islands). Elsewhere – unknown.

Habitat In Alaska – colonies grow on hard rock (bedrock, boulders, cobbles, pebbles, and siltstone) and often encrust a suite of biotic substrates including the skeletons of octocorals (gorgoniids and keratoisidids), stylasterids, hexactinellid skeletons, bivalve shell (scallop), and bryozoans at depths of 82 to 990 m. The corals appear to grow partly on living tissue, at least in the case of the stylasterids (see photo A).

Photos A) A fresh whole *Clavularia* sp. A colony (CAS 235595) growing on a *Distichopora borealis* colony collected on Amchixtam Chaxsxii in the central Aleutian Islands at a depth of 744 m. B) A fresh whole *Clavularia* sp. A colony (USNM 1116851) growing on the bare skeleton of a *Callistephanus pacificus* colony collected in Zhemchug Canyon in the eastern Bering Sea at a depth of 494 m. C) A close-up view of the same colony in photo B. D) A close-up view of the section of the same colony in photo B growing directly on the cobble to which the host coral was attached. E) A *Clavularia* sp. A colony (indicated by the white circle) observed on a slope heavily disturbed by fishing activities on Amchixtam Chaxsxii at a depth of 165 m. The distance between the red laser marks is 10 cm. F) Several *Clavularia* sp. A colonies observed northwest of Tanaga Island in the central Aleutian Islands at a depth of 160 m.



CHAPTER 7

Family Gorgoniidae

(Adapted from McFadden et al., 2022) Gorgoniids are octocorals with a proteinaceous skeletal axis that may contain non-scleritic carbonate hydroxylapatite. The axis is hollow with a narrow cross-chambered core and a dense cortex with little loculation. Colonies are erect, variably branched, planar or bushy, and often anchored by a strong holdfast that may be calcified. Polyps are monomorphic, retractile into coenenchyme or low mounds, and distributed over all surfaces or arranged biserially on the branches. Polyp sclerites are flattened rods with variable margins and coenenchyme sclerites are radiates and small spindles; all are often brightly colored.

Of the 13 known genera of Gorgoniidae, only *Callistephanus* (two species) is found in Alaska waters. Both species are common and have a broad distribution along the Gulf of Alaska continental shelf, seamounts in the Gulf of Alaska Seamount Province, the Aleutian Islands, and the eastern Bering Sea as far north as Pervenets Canyon (Fig. 7-1). They are deep-water and eurybathic fauna occupying depths between 96 and 2778 m and grow directly on hard rock (bedrock, fractured bedrock, boulders, cobbles, pebbles, and siltstone).

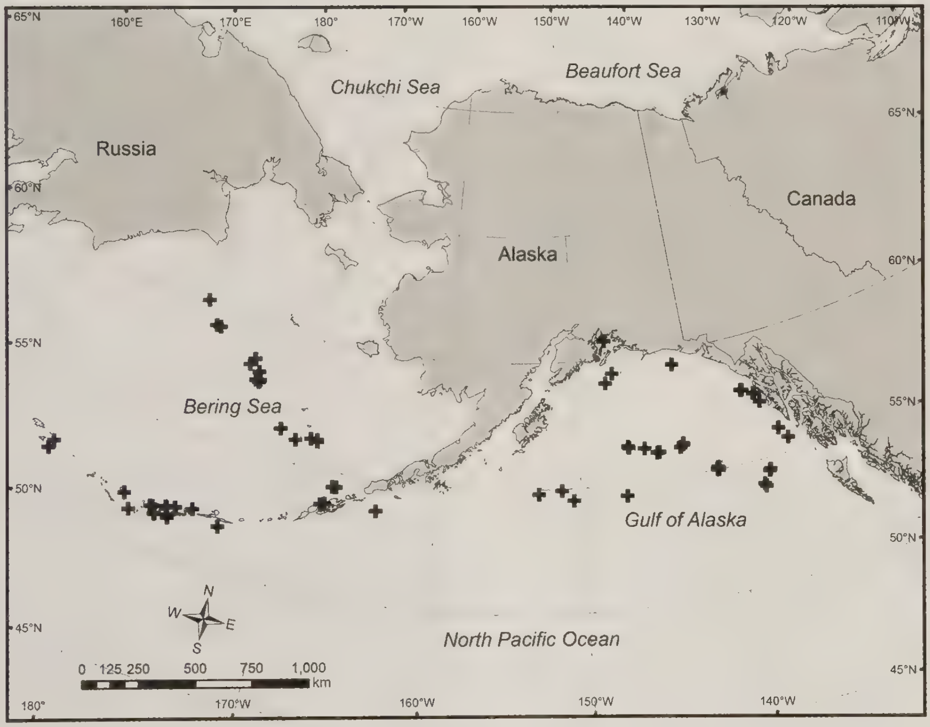

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 7-1

A map of the North Pacific Ocean showing the distribution of corals in the family Gorgoniidae (+) in Alaska waters.

1. *Callistephanus pacificus* Nutting, 1912

Description (Adapted from Nutting, 1912 and Horvath, 2019) Colonies are flabellate, almost always in one plane, and moderately to densely branched. The largest known specimen (USNM 1481935) is 28 cm in height and 40 cm in width but larger specimens have been observed in situ. In general, branching is highly irregular but may be opposite or alternate and to the 4th order and 5th order in the largest colonies. Secondary branches may be quite short, giving the appearance of anastomosis; most branches curve upwards. Secondary branching starts very close to a relatively stout and cup-shaped holdfast; sometimes two colonies apparently share the same holdfast. The axis is woody, strong, and difficult to tear; it is dark brown but lighter near the branch tips. Colonies are crimson red to brilliant orange in life and the polyps are often highlighted with orange; the coenenchyme is a paler cranberry red when dried or preserved in ethanol.

The calyces are prominent, conical and rounded, mostly lateral on the branches, alternate and opposite in position, and about 3–4 mm apart. Typical calyces measure 1.2 mm in height and 2.2 mm in diameter. The anthocodiae are well developed, fully retractile but slightly exsert in preserved specimens, with only the crown resting on the calyx margin. Colonies are able to retract their polyps very quickly when disturbed during collection.

Polyp sclerites are bright red or orange rods and pale pinkish-red warty spindles and capstans. The tentacles are armed with numerous spindles arranged *en chevron* basally and in longitudinal rows distally. The coenenchyme sclerites are unilaterally developed superficial capstans and spindles (0.08–0.17 mm in length) with flatter warty spindles in the layer beneath.

Remarks This species was originally described by Nutting (1912) as *Callistephanus pacificus* but until just recently was known as *Swiftia pacifica* (Nutting, 1912). This species has a very broad geographic and bathymetric distribution and morphological characteristics that apparently overlap with congeners (Horvath, 2019). Accordingly, Breedy et al. (2015) suggested that a thorough review of *Callistephanus* be undertaken to clarify taxonomic issues, including the presence of sibling or cryptic species.

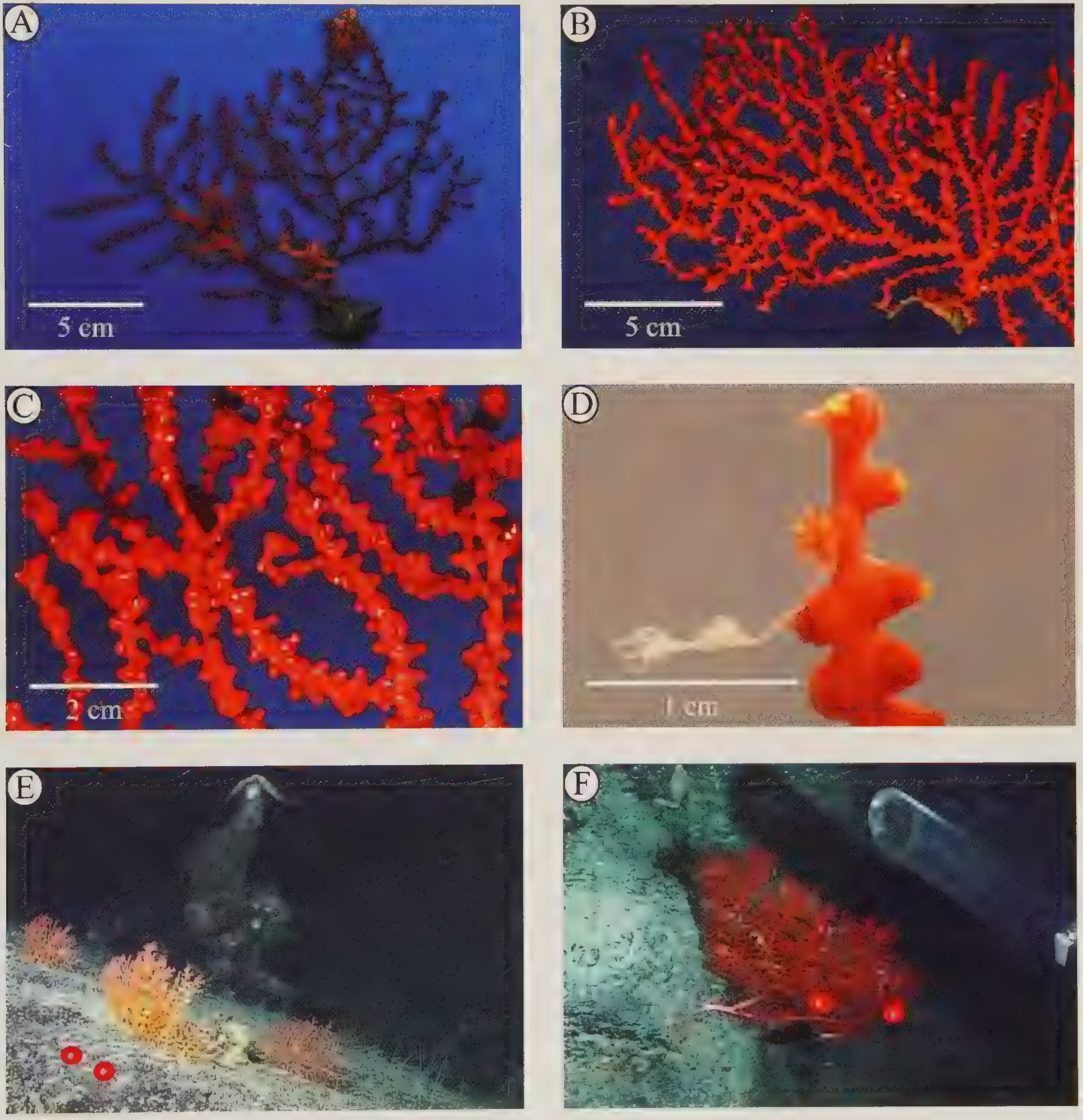
We have observed a hydroid that is superficially similar to *Callistephanus* including *C. pacificus* in the central Aleutian Islands. This hydroid is bushy with what we call a "creeping" appearance, not upright, delicately branched and wiry, with up to eight scraggly branches (8–10 cm in length) that originate near the base, and is crimson red in color with pink or dark orange highlights. The hydroid was observed in southern Amchitka Pass at depths between 274 and 352 m where the seafloor was heavily disturbed by bottom-contact fishing gear, littered with sponge and coral debris, and mostly inhabited by fast-growing species of hydroids. *Callistephanus pacificus* were not observed at this site but they do occur elsewhere in Amchitka Pass, usually in slightly deeper water.

This species hosts an extremely rich suite of associated fauna, including amphipods (caprellids, pleustids, stenothoidids, and the ischyrocerid *Bonnierella* sp.), isopods (antarcturids and aegids), and pycnogonids (Watling and Stone[7]). Hydroids and small actiniarians often grow on bare sections of the axial skeleton, and several species of ophiuroids (including *Ophiopholis japonica* and *Ophiura leptoctenia*) are common associates. Colonies on seamounts in the Gulf of Alaska Seamount Province occasionally host the large sternostylid crab *Sternostylus iaspus* and the large ophiuroid *Asteronyx*. The coenenchyme and sclerites are principally composed of high-magnesium calcite (8.6 mol% $MgCO_3$) with minute amounts of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Widespread (Fig. 7-2) and locally common. In Alaska – eastern and western Gulf of Alaska (west of Prince of Wales Island to Prince William Sound), the Gulf of Alaska Seamount Province (Densen, Welker, Pratt, Surveyor, Marchand, and Chirikof Seamounts), the Aleutian Islands (south of Unimak Island to near Agattu Island), and the eastern Bering Sea slope (Pribilof Canyon to north of Pervenets Canyon). Notably, the holotype (USNM 30024) collected east of Semichi Island by the U.S. Fisheries Steamer *Albatross* in 1906 is one of only two records from the western Aleutian Islands. Elsewhere – northern British Columbia (west of the Queen Charlotte Islands) to central Oregon (off Cape Meares).

Habitat In Alaska – attaches to hard rock including bedrock, fractured bedrock, siltstone, boulders, cobbles, and large pebbles on sloped habitats and at depths between 96 and 2778 m. There are, however, only three records shallower than 485 m (96 m, 210 m, and 278 m). Found in small patches with maximum densities of 8 colonies/m^2, often in association with *C. simplex*, and additionally *Paragorgia* sp. A and *Isidella tentaculum* on seamount habitats. Elsewhere – found at depths between 251 m (off Washington) to 2904 m (British Columbia).

Photos A) A fresh whole C. *pacificus* colony (USNM 1481937) collected west of Chichagof Island, eastern GOA, at a depth of 816 m. B) A fresh whole C. *pacificus* colony (USNM 1481941) collected in Zhemchug Canyon, eastern Bering Sea, at a depth of 520 m. C) A close-up view of the same specimen in photo B. D) A fresh C. *pacificus* specimen (USNM 1481933) with an attached caprellid amphipod collected south of Tanaga Island, central Aleutian Islands, at a depth of 824 m. E) *Callistephanus pacificus* colonies photographed on Welker Seamount at a depth of 1120 m. F) A C. *pacificus* colony (USNM 1075771) collected on Densen Seamount at a depth of 2402 m. The distance between the red laser marks in photos E and F is 10 cm.



1. *Callistephanus pacificus* Nutting, 1912 (continued)

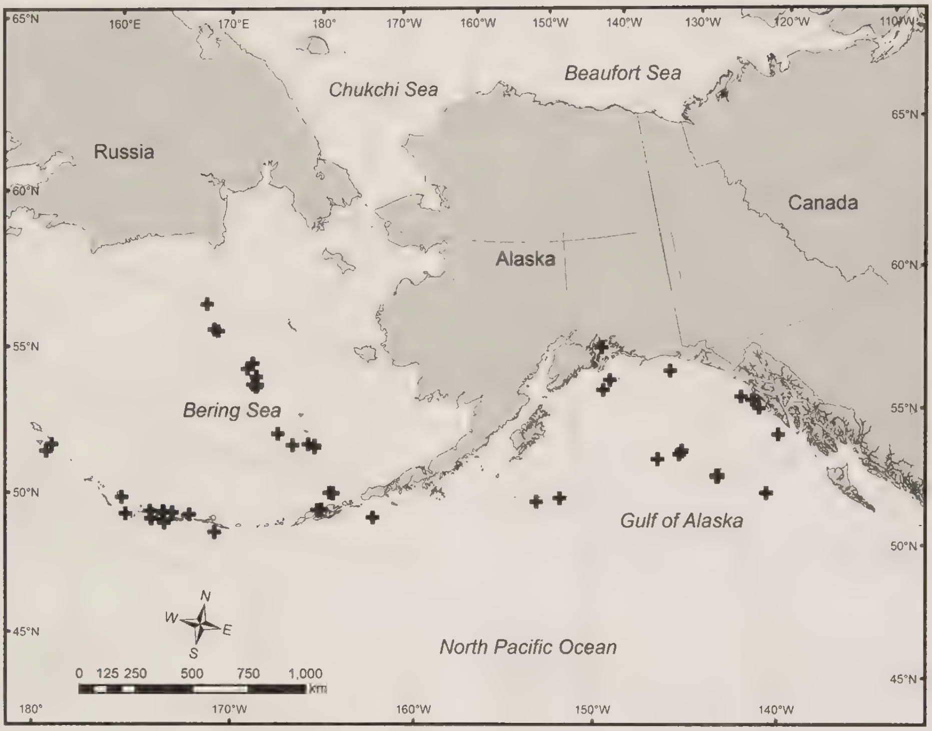

Russia
Chukchi Sea
Beaufort Sea
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 7-2

A map of Alaska showing the distribution of *Callistephanus pacificus* (+) in Alaska waters.

2. *Callistephanus simplex* (Nutting, 1909)

Description (Adapted from Nutting, 1909) Colonies are sometimes scraggly, whip-like, quite flexible, and unbranched or only slightly branched; colonies have up to 12 branch tips but with 5th order branching (see photo A on next page). The main axis and branches are round, slender, and of relatively uniform thickness throughout (3.6–5.2 mm). Colonies are up to at least 50 cm in height. The holdfast is generally discoid, stout, and robust, and often covered with coenenchyme. The coenenchyme is relatively thin for the family.

Calyces are uniformly distributed, not crowded, often spaced apart by as much as 2 mm, tubular, small (approximately 1 mm in height), and usually higher than broad. The polyp walls contain red spindle-shaped sclerites, as do the areas on and near the tentacle bases, where they are arranged more or less *en chevron*. Otherwise the sclerites are longitudinally arranged.

The sclerites are mainly of two types: 1) small double spindles, rosettes, stars, and small clubs located mostly in the superficial layer of the coenenchyme, and 2) larger spindles that are slender, pointed, often slightly curved, covered with regularly distributed verrucae, and much more abundant than the small double spindles. The clubs are much less numerous than the other sclerite forms.

Color of the coenenchyme in life is crimson red to bright orange, and the polyps are a lighter shade than the coenenchyme. Color in dried specimens is similar, but polyps are a darker shade than the coenenchyme.

Remarks Until recently this species was known as *Swiftia simplex* (Nutting, 1909). Seamount colonies often host ophiuroids including the large *Asteronyx* sp. and the large sternostylid crab (*Sternostylus iaspus*) that uses the colony as an elevated feeding platform, and damaged or dying specimens are often covered with hydroids. The coenenchyme and sclerites are principally composed of high-magnesium calcite (8.9 mol% $MgCO_3$) with minute amounts of aragonite and calcite (senior author and S. D. Cairns, unpubl. data).

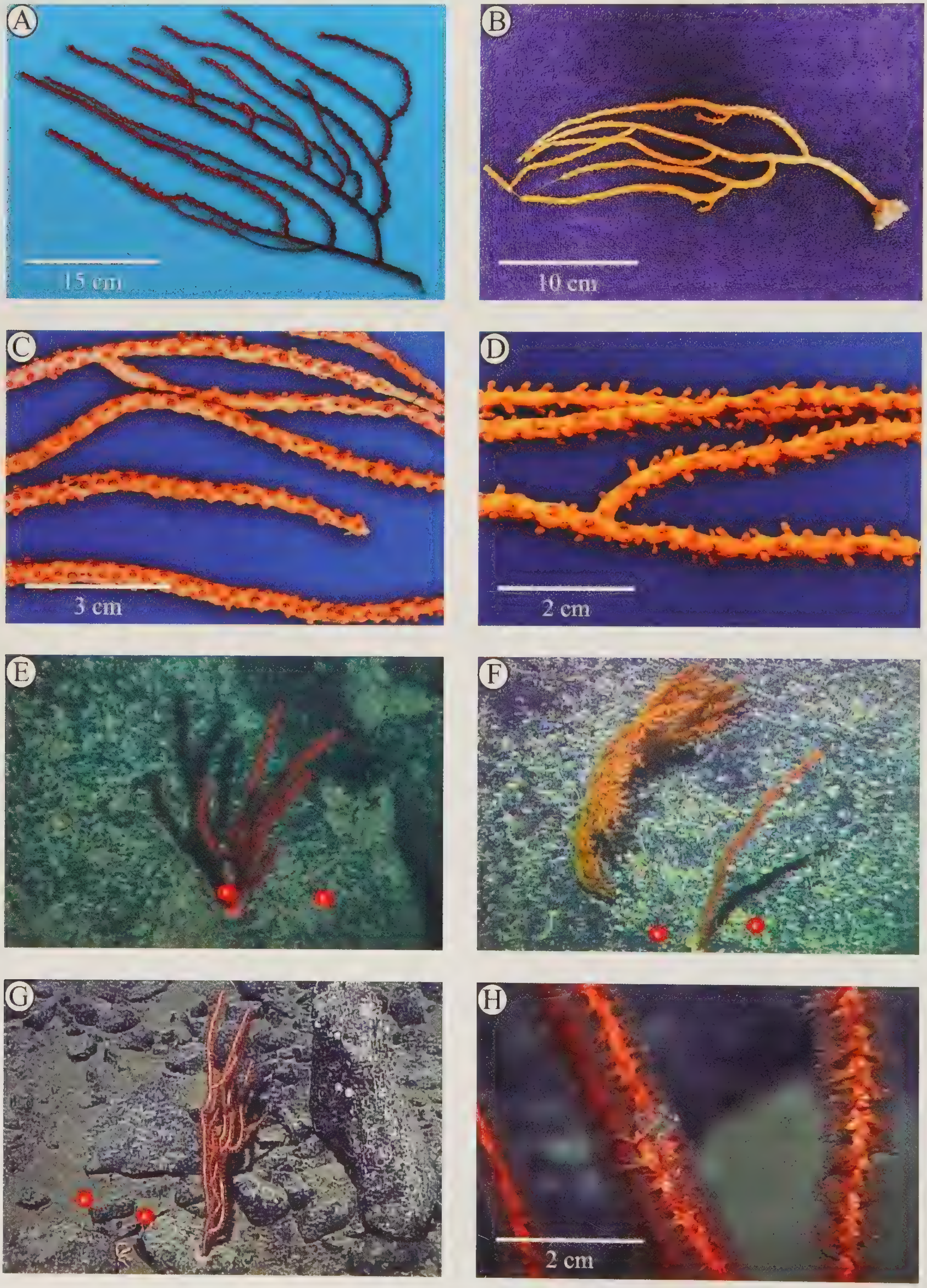
The reproductive biology (Feehan and Waller, 2015) and connectivity of populations along the U.S. Pacific Coast have been studied using restriction-site associated DNA sequencing (Everett et al., 2016).

Distribution Locally common. In Alaska – the eastern Gulf of Alaska continental slope and Dickens, Densen, Welker, Surveyor, Pratt, Quinn, Giacomini, and Patten Seamounts in the Gulf of Alaska Seamount Province (Fig. 7-3). A single specimen was collected west of Tanaga Island in the central Aleutian Islands. Elsewhere – Washington to the Channel Islands, California. The type specimens (USNM 25431) were collected off Santa Cruz Island (817–819 m).

Habitat In Alaska – found in small patches (up to 5 colonies/m^2), occasionally singly, on bedrock, siltstone, boulders, cobbles, and pebbles at depths between 500 and 1352 m. Often co-occurs with *C. pacificus*. Elsewhere – found at depths between 549 and 1463 m.

Photos A) A fresh whole (except the holdfast) *C. simplex* colony (GOA06-100B-01) collected west of Chichagof Island, eastern Gulf of Alaska, at a depth of 816 m. B) A dried whole *C. simplex* colony (USNM 1481924) collected southeast of the Fairweather Ground, eastern Gulf of Alaska, at a depth of 769 m. C) A close-up view of the same specimen in photo B. D) A close-up view of a dried *C. simplex* specimen (USNM 1481923) collected southeast of the Fairweather Ground at a depth of 651 m. E) A *C. simplex* colony (USNM 1075782) collected on Welker Seamount at a depth of 793 m. F) A *C. simplex* colony (USNM 1075781) collected at the same location as the specimen in photo E with a *C. pacificus* colony (USNM 1075781). G) A *C. simplex* colony (USNM 1075798) collected on Pratt Seamount at a depth of 1179 m. H) A close-up view of the same colony in photo G. The distance between the red laser marks in photos E–G is 10 cm.

2. *Callistephanus simplex* (Nutting, 1909) (continued)


A
15 cm
B
10 cm
C
3 cm
D
2 cm
E
F
G
H
2 cm

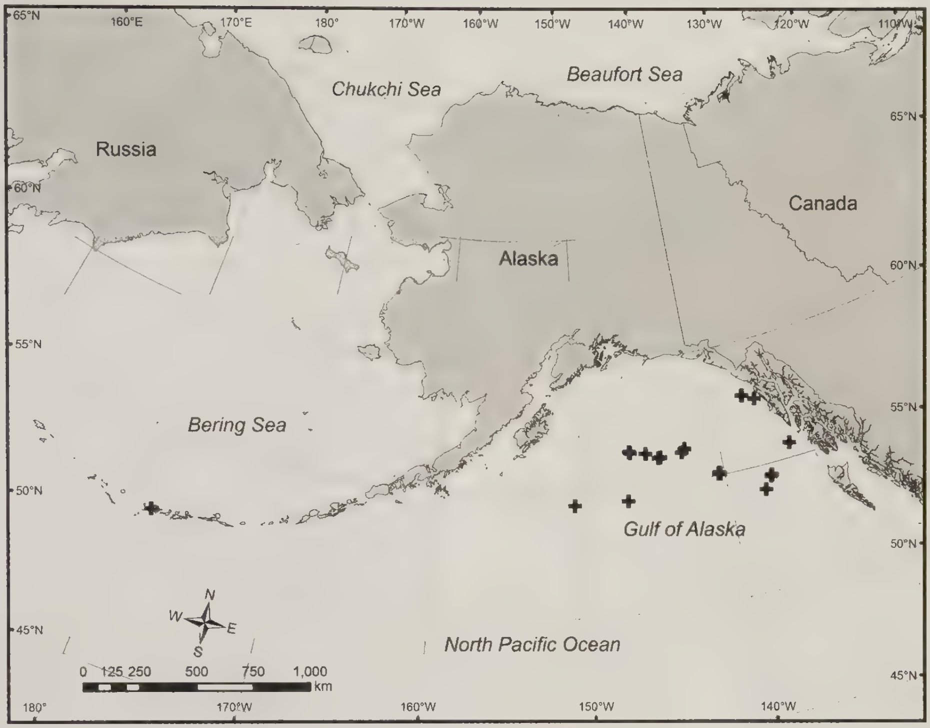

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
65°N
60°N
Canada
Alaska
60°N
55°N
Bering Sea
55°N
50°N
Gulf of Alaska
50°N
45°N
N
W
E
S
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 7-3

A map of Alaska showing the distribution of *Callistephanus simplex* (+) in Alaska waters.

CHAPTER 8

Family Malacalcyonacea *incertae sedis*

As part of their recent revised systematics of the Octocorallia, McFadden et al. (2022) placed 46 genera and two unaccepted families of corals into a group *incertae sedis*. They determined that the phylogenetic positions of these corals were unknown or uncertain. The World Register of Marine Species currently lists these taxa in the family Malacalcyonacea *incertae sedis*. The majority of these taxa are rare and few specimens are available for molecular analyses. The *mtMutS* phylogeny for all of the Alaska genera placed in this group (*Alaskagorgia*, *Calcigorgia*, *Cryogorgia*, and *Elenanthus*) do not fit into any of the 55 currently accepted families studied by McFadden et al. (2022), even though all but *Elenanthus* are common where they occur and many specimens have been collected for study. The authors indicate that their phylogenetic positions require further confirmation from genomic data and that it would not be surprising if some of them prove to be unique family-level clades.

Alaska corals included in this new family include two species of *Alaskagorgia* (previously placed in the family Plexauridae, suborder Holaxonia), five species of *Calcigorgia* (previously placed in the family Acanthogorgiidae, suborder Holaxonia), the only species of *Cryogorgia* (previously placed in the family Plexauridae), and the only species of *Elenanthus* (previously placed in the family Clavulariidae). These corals have a limited and peculiar distribution in Alaska (Fig. 8-1). All species are principally found in the Aleutian Islands except for two —*Calcigorgia spiculifera* Broch, 1935 and *Calcigorgia beringi* (Nutting, 1912)—that are also found in the eastern Gulf of Alaska. Corals in this family are found at depths between 12 and 2210 m.

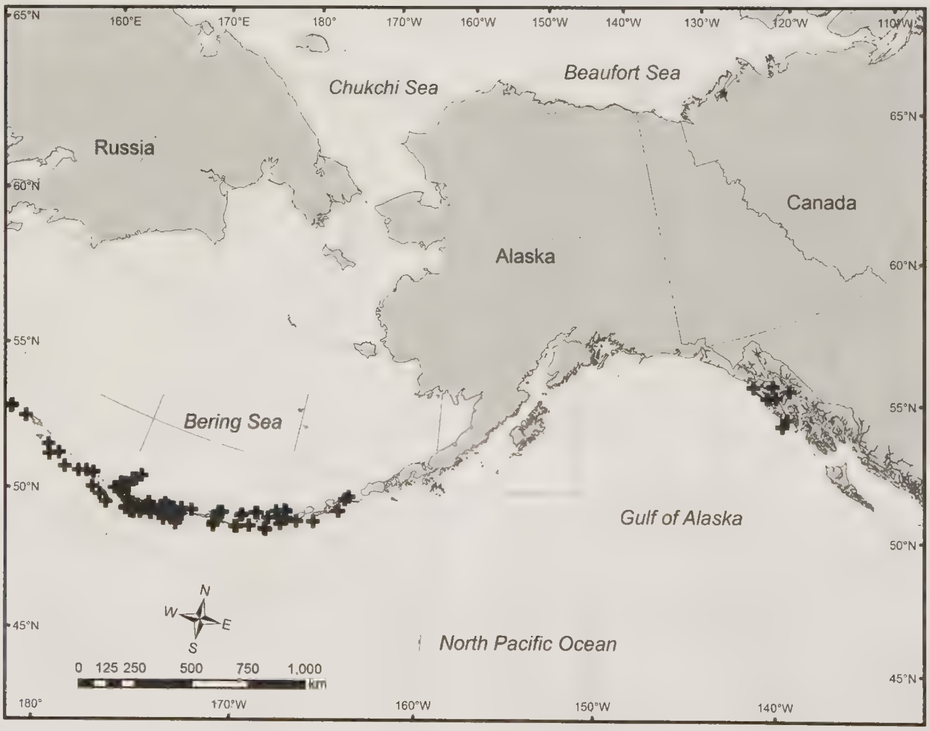

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
60°N
65°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 8-1

A map of the North Pacific Ocean showing the distribution of corals in the family Malacalcyonacea *incertae sedis* (+) in Alaska waters.

1. *Alaskagorgia aleutiana* Sánchez and Cairns, 2004

Description (Adapted from Sánchez and Cairns, 2004) Colonies are stout, upright, and sparsely branched; they have up to eight lateral branches but are typically monopodial in smaller specimens (<30 cm). The largest known specimen is 84 cm in height with branch diameters of 15–22 mm. Branch tips are more or less clavate. The holdfast is robust; the axial skeleton is woody, somewhat flexible but strong, and dark brown with faint linear striations. The coenenchyme is thick, can easily be peeled away from the axial skeleton in sheets, and is dark yellow to various shades of orange in life, pale orange when dried, and may turn blackish when frozen. For best preservation, specimens should not be frozen for an extended period of time.

Polyps are scattered on all sides of the branches and housed within raised circular and oval calyces that are up to 5.5 mm in diameter and have eight prominent notches. The anthocodiae are fully retractile into a thick cortex but are often exsert in preserved specimens.

The tentacular portion of the polyps is densely armed with pointed, tuberculate spindles (>0.6 mm in length) that may have projecting processes. The thick coenenchyme has three distinct layers, each with predominant sclerite types. The thin surface layer contains small double heads; the thick middle layer contains the gastric cavities of the retracted polyps and oval capstans with elaborate ornamentation. The inner layer (axial sheath) also contains capstans that are less ornamented and typically octoradiate.

Remarks *Alaskagorgia aleutiana* is typically found in complex habitats and is an excellent indicator species of coral garden habitat. Associates include several species of ophiuroids. The coenenchyme and sclerites are principally composed of high-magnesium calcite (9.1 mol% $MgCO_3$) with minute amounts of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – known only from the Aleutian Islands (south of Yunaska Island to east of Stalemate Bank) including Petrel Bank (Fig. 8-2). Elsewhere – not reported.

Habitat In Alaska – found in complex habitat in areas of moderate current, growing on bedrock, boulders, cobbles, and siltstone (in deeper waters only). Collected

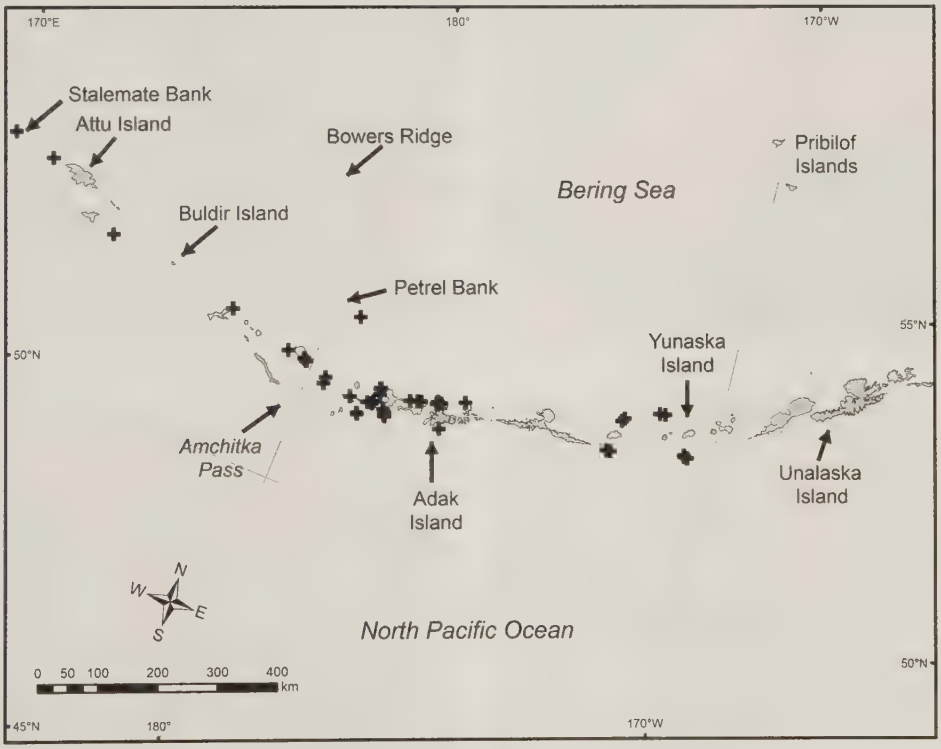
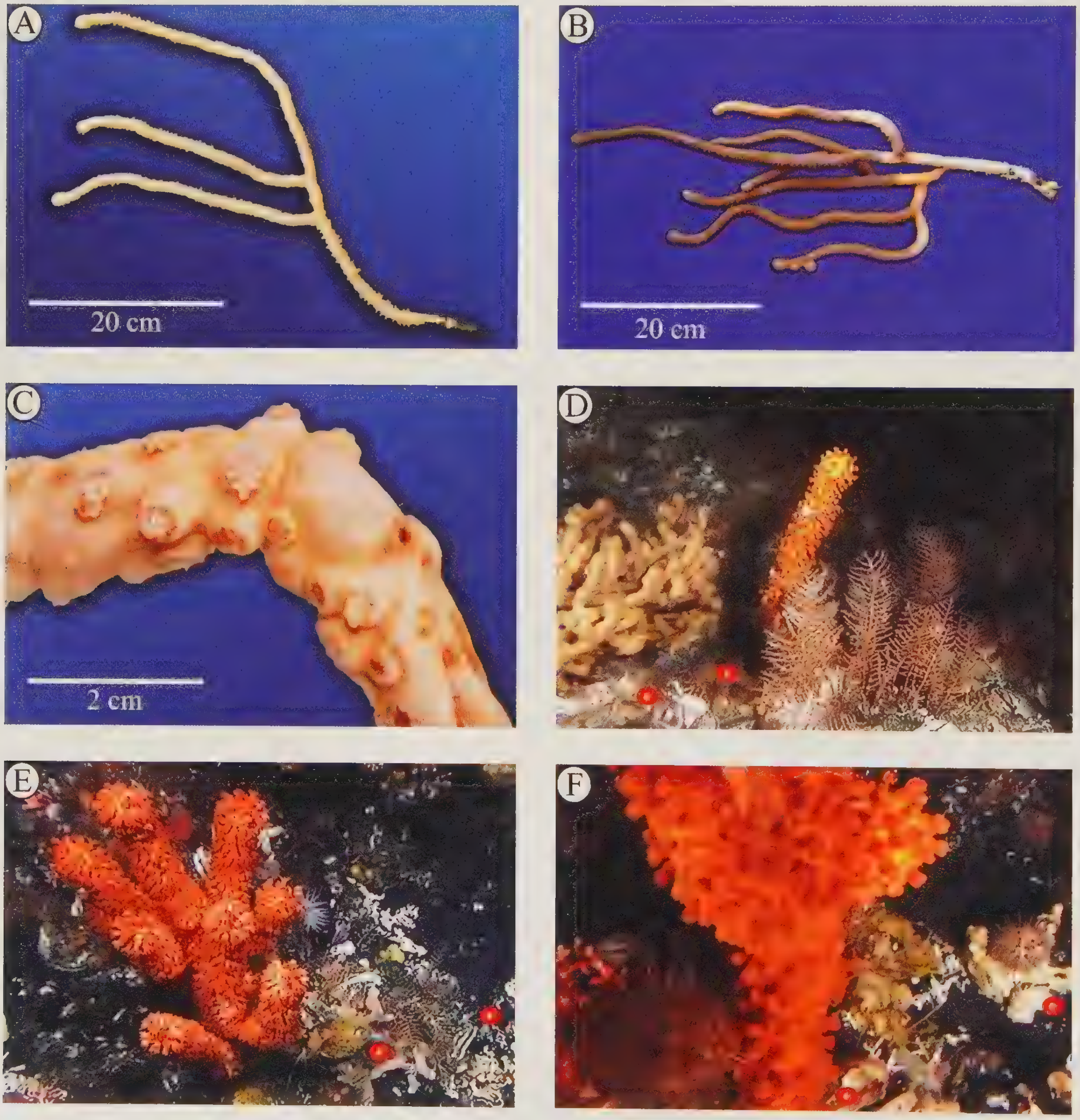


Figure 8-2

A map of the Aleutian Islands showing the distribution of *Alaskagorgia aleutiana* (+) in Alaska waters.

specimens range in depth from 87 to 824 m but it has been observed on video footage to depths between 1030 and 1044 m in northern Kanaga Pass and to 1255 m on Amchixtam Chaxsxii (senior author, personal observ.).

Photos A) A fresh whole (except the holdfast) *A. aleutiana* colony (USNM 1484182) collected near the Delarof Islands, central Aleutian Islands, at a depth of 120 m. B) A fresh whole *A. aleutiana* colony (USNM 1484185) collected southwest of Tanaga Island, central Aleutian Islands, at a depth of 87 m. C) A close-up view of a fresh *A. aleutiana* specimen (USNM 1484146) collected on Petrel Bank, central Aleutian Islands, at a depth of 154 m. D) An *A. aleutiana* colony (USNM 1115604) collected off Cape Moffet, Adak Island, central Aleutian Islands, at a depth of 140 m. E) An *A. aleutiana* colony photographed northwest of Tanaga Island, central Aleutian Islands, at a depth of 180 m. F) A close-up view of the lower stalk of the same colony in photo E. The distance between the red laser marks in photos D–F is 10 cm.



2. *Alaskagorgia splendicitrina* Horvath and Stone, 2018

Description The holotype colony is flabellate with numerous (about 34), robust branches that are somewhat convoluted, turning in all directions, but not anastomosing. Branches are about 5 mm in diameter (not including polyps); tips are noticeably clavate. The colony is upright (approximately 12 cm in height) but rather squat and broad (approximately 25 cm in width). The holdfast is cup-shaped with irregular margins and is completely covered with coenenchyme. The axial skeleton is woody, quite flexible, and black near the base but olive-brown distally. The coenenchyme is a bright, vibrant lemon-yellow when freshly collected and presumably in situ, but turns a dull olive-brown when frozen and dried.

The polyps are large, exposed, and numerous, scattered all over the branches with few or none on the stalk and holdfast. The anthocodiae are fully retractile into a thick coenenchyme but many are preserved exsert in the holotype. The cortex is conspicuously raised around the polyp openings, forming short, cylindrical protuberances as broad, rounded domes or grooved pyramids up to 3.0 mm in height and diameter, round to oblong in shape, and eight-lobed. Tentacles appear to be rather long, extending beyond the aperture edge about 3 mm, and joined together to form a tall grooved column.

Sclerites are generally those typical of the genus. Anthocodiae are rather densely armed with somewhat pointed, tuberculate spindles, many nearly 0.5 mm in length. The coenenchyme has three layers. The surface layer is quite thin and contains small (0.07–0.09 mm in length) oval capstans. The middle layer is thick, containing numerous dense gastric cavities, and has oval capstans (0.03–0.18 mm in length). The inner layer is quite thin, containing the axial sheath and simple or modified octoradiate sclerites (0.10–0.20 mm in length). Most sclerites are a very pale yellow.

Remarks The holotype collected in the far western region of the Aleutian Island Archipelago is the only known specimen, despite extensive collections from fisheries and research surveys throughout the region. This species most likely radiated from the much less explored region to the west, including the Commander (Komandorskie) Islands and Kamchatka Peninsula of the Russian Far East, and is endemic to the Northwest Pacific region.

Preliminary genetic analyses have been undertaken (Thoma, 2013) and additional work is ongoing to determine the similarities at the molecular level between this species, *A. aleutiana*, and an apparent third undescribed species of *Alaskagorgia* from deep water (824 m) in the central Aleutian Islands (Horvath and Stone, 2018). The status of the genus regarding higher level taxa, such as family, are also being investigated with molecular genetics (Everett[8]).

The holotype hosted 23 brittle stars (class Ophiuroidea) including 20 *Ophiosemnotes pachybactra* and three *Astronebris tatafilius* (Hendler[9]).

Distribution Rare. In Alaska – known only from the type locality on Stalemate Bank in the far western region of the Aleutian Islands (Fig. 8-3). Elsewhere – not reported.

Habitat The holotype was collected at a depth of 184 m, likely in an area of small cobbles, pebbles, and sand with moderate bottom currents.

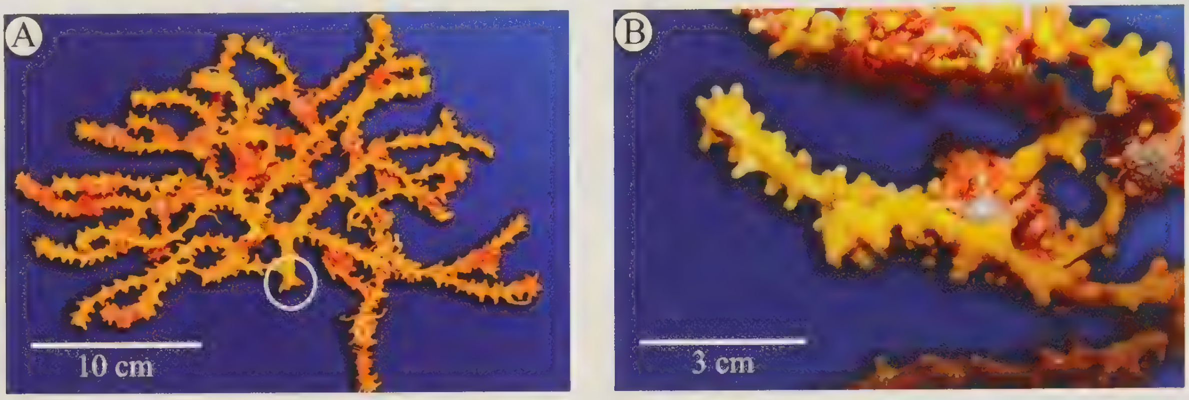
Photos A) The dried *Alaskagorgia splendicitrina* holotype (USNM 1498741; whole colony) collected on Stalemate Bank, western Aleutian Islands, at a depth of 184 m. The holdfast is highlighted in the white circle. B) A close-up view of the same specimen in photo A.

---

[8] Everett, M. 2020. Personal commun. National Marine Fisheries Service, Northwest Fisheries Science Center, 2725 Montlake Blvd E, Seattle, WA 98112.

[9] Hendler, G. 2019. Personal commun. Natural History Museum of Los Angeles County, 900 Expedition Boulevard, Los Angeles, CA 90007.

2. *Alaskagorgia splendicitrina* Horvath and Stone, 2018 (continued)



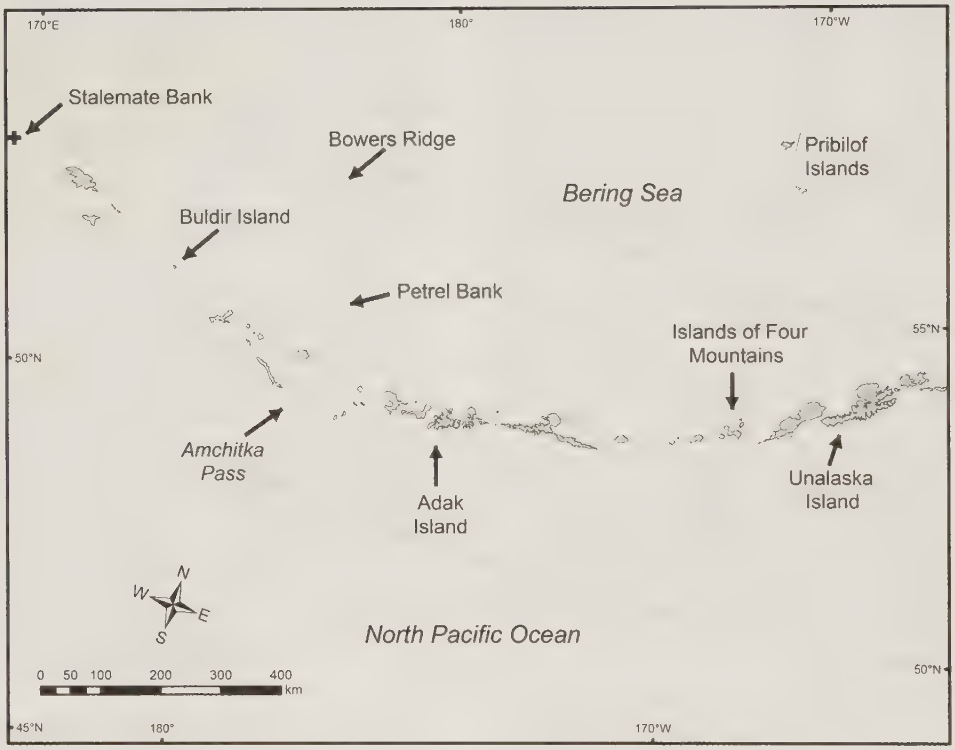

170°E
180°
170°W
Stalemate Bank
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 8-3

A map of the Aleutian Islands showing the distribution of *Alaskagorgia splendicitrina* (+) in Alaska waters.

3. *Calcigorgia beringi* (Nutting, 1912)

Description (Adapted from Nutting, 1912) Colonies are either flabellate or bushy, somewhat spindly and highly branched in the largest colonies. Branching is irregular and to at least the 5th order. The largest colonies are 55 cm in height and 35 cm in width. Holdfasts are strong, circular, and typically covered with coenenchyme. Tubular calyces are very prominent, mainly lateral and often anterior in position. The back of the colony is often bare. Typical calyces are 2.5 mm in height and 1.3 mm in diameter. Eight broad shallow longitudinal folds near the margin extend upward over the bases of the tentacles and form a thick crust on the dorsal surfaces and eight lobes to the calyx margin.

The sclerites are very small, short terete spindles, and densely tuberculate with the tubercles forming regular whorls around the body of the sclerite. Sometimes there is a girdle without tubercles around the center, forming double spindles or double heads.

The central axis is woody, flexible, and black in color (nearer the holdfast) to dark brown (distally). The coenenchyme is light orange to pinkish orange; in some specimens the coenenchyme is so thin that the axial skeleton is visible beneath.

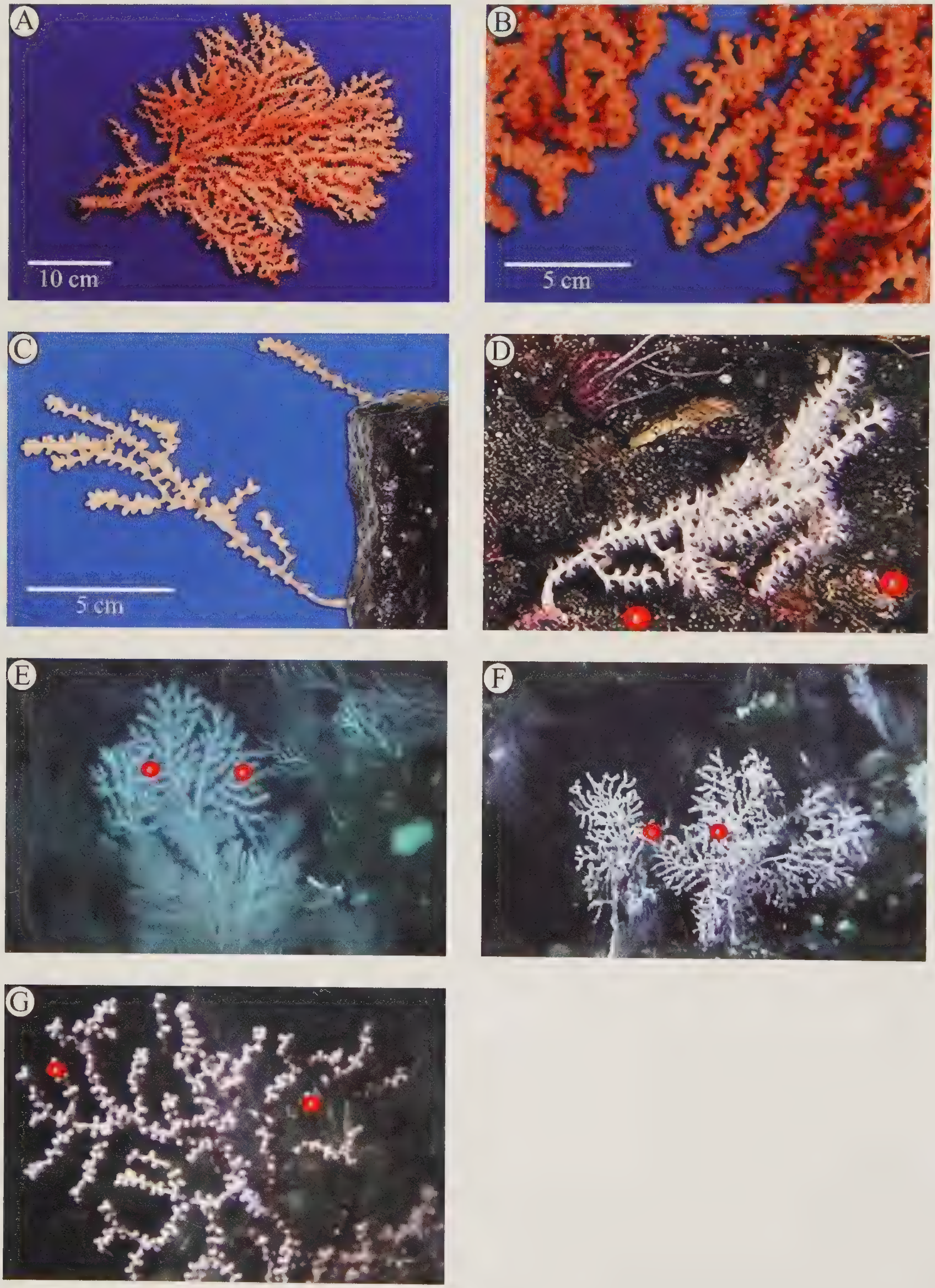
Remarks Associated fauna include pleustid and stenothoidid amphipods, the hydroid *Bonneviella superba*, and ophiuroids (Watling and Stone[7]). It is preyed upon by the spiny red sea star (*Hippasteria phrygiana*) and calliostomatid snail *Otukaia beringensis* in the central Aleutian Islands (Stone, 2014; Tuskes and Clark, 2018). The coenenchyme and sclerites are principally composed of high-magnesium calcite (8.8–9.0 mol% $MgCO_3$) with small amounts of aragonite and calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – this species has a highly disjunct distribution (Fig. 8-4); the Aleutian Islands (Akutan Pass to southwest of Buldir Island) and eastern Gulf of Alaska (Shutter Ridge). Elsewhere – not reported, but there is one specimen identified by Matsumoto et al. (2019) from off Cape Flattery, Washington, as *Calcigorgia japonica*. However, we tentatively list that specimen as *C. beringi* (which it much more closely resembles) until the specimen can be re-examined.

Habitat In Alaska – occurs in scattered patches on bedrock, boulders, cobbles, and occasionally hexactinellid skeleton; often in areas of moderate current; and at depths between 87 and 1247 m. Video observations from the central Aleutian Islands indicate that this species is present at depths to 1933 m (senior author, personal observ.). The holotype (USNM 30044) was collected southwest of Buldir Island with a beam trawl from the U.S. Fisheries Steamer *Albatross* on 6 June 1906 at a reported depth of 1914 m. However, we measured a depth of only 212 m at the reported collection location from modern National Oceanic and Atmospheric Administration nautical charts.

Photos A) A fresh whole *C. beringi* colony (USNM 1481959) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 92 m. B) A close-up view of the same specimen in photo A. C) Fresh whole *C. beringi* colonies (USNM 1481960) collected on Shutter Ridge, eastern Gulf of Alaska, at a depth of 244 m. D) The same colonies in photo C with polyps fully extended, just before collection. E) A *C. beringi* colony photographed on Amchixtam Chaxsxii in the central Aleutian Islands at a depth of 903 m. F) Two *C. beringi* colonies (left: USNM 1659742; right: USNM 1481957) collected on Amchixtam Chaxsxii at a depth of 861 m. G) A *C. beringi* colony (USNM 1659742) with polyps fully retracted. The distance between the red laser marks in photos D–G is 10 cm.

3. *Calcigorgia beringi* (Nutting, 1912) (continued)


A
10 cm
B
5 cm
C
5 cm
D
E
F
G

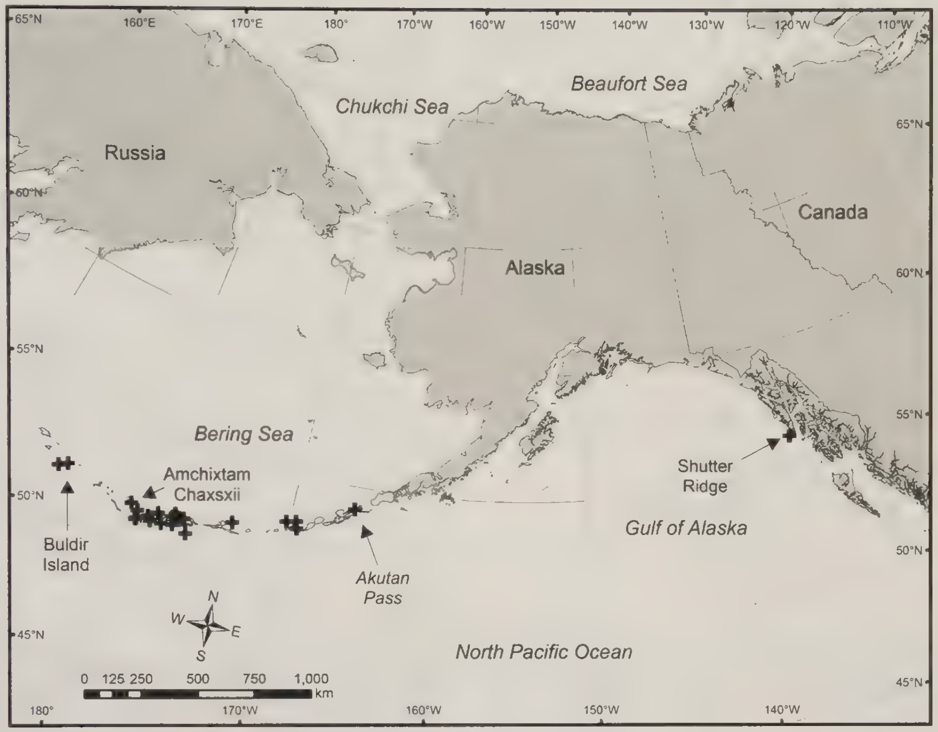

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
65°N
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
Amchixtam Chaxsxii
50°N
Buldir Island
Shutter Ridge
Gulf of Alaska
50°N
Akutan Pass
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 8-4

A map of the North Pacific Ocean showing the distribution of *Calcigorgia beringi* (+) in Alaska waters.

4. *Calcigorgia gigantea* Matsumoto et al., 2019

Description Colonies are robust but small; the largest of three known colonies (holotype) is 10 cm in height and 7 cm in width. The central axis is quite robust, about 6 mm wide (without coenenchyme), woody, and somewhat flexible. The holdfast is well defined and somewhat discoid. The holotype has only two secondary branches. Polyps are non-retractile and quite large (9–10 mm in height by 5–6 mm in width). Tentacles lack sclerites. Polyp sclerites consist of poorly developed clubs (≥0.6 mm in length) and spindles (≥0.9 mm in length), both with simple tubercles.

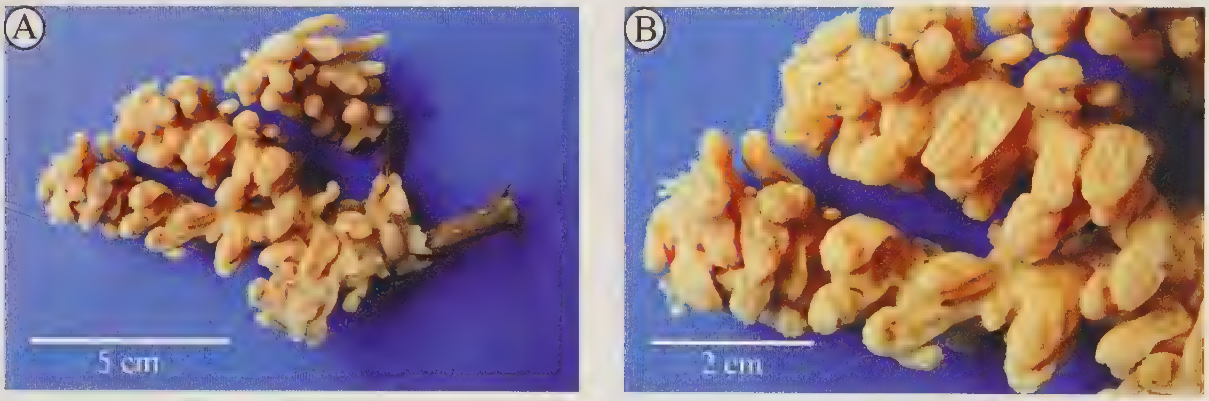
Ethanol-preserved specimens are light orange. The axial skeleton is a medium brown.

Remarks This species is unique among the genus with its very large polyps and sclerites, hence the name of the species given by the authors—*gigantea* (Latin for giant or very large).

Distribution Rare. In Alaska – central and western Aleutian Islands (Fig. 8-5). Known from only three specimens collected near Amchitka Pass (Tanaga Pass to north of Semisopochnoi Island). Elsewhere – not reported.

Habitat Attaches to hard substrate, most likely cobbles and pebbles, in areas of moderate current, and at depths between 135 and 381 m.

Photos A) The preserved (in ethanol) *C. gigantea* holotype (USNM 1013069; whole colony) collected in Tanaga Pass, central Aleutian Islands, at a depth of 381 m. B) A close-up view of the same specimen in photo A.



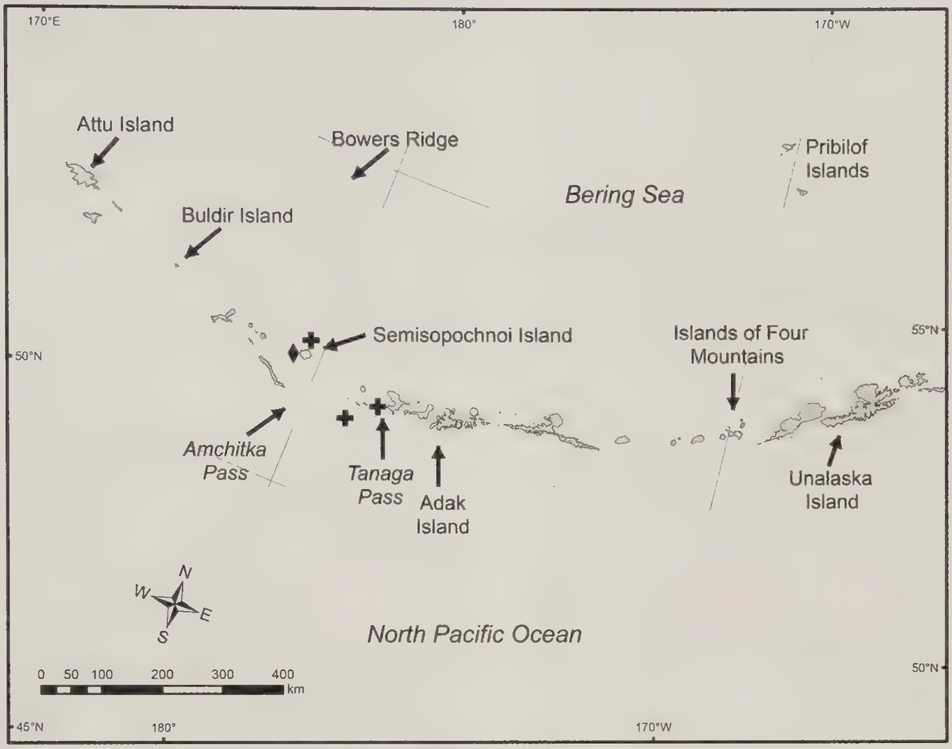

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Semisopochnoi Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Tanaga Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 8-5

A map of the Aleutian Islands showing the distribution of *Calcigorgia gigantea* (+) and *C. matua* (♦) in Alaska waters.

5. *Calcigorgia japonica* Dautova, 2007

Description (Adapted from Dautova, 2007) Colonies are often monopodial, sometimes branched, and somewhat planar. The largest colony is 31 cm in height with 12 branch tips, although most are less than 8 cm in height with four or fewer branches. Branching is a mixture of openly lateral and irregularly dichotomous, up to 5th order branching. The central axis or stalk and branches have a width of 2–4 mm and are wiry, with a leathery coenenchyme consisting of a thick outer layer with a smooth surface and a very thin, semi-transparent inner layer. The naked, bare part of the stalk is highly variable in length and may range close to almost half of the colony. The colony is attached to the substrate with a nearly circular holdfast. The central axis is black to dark brown, woody, and flexible.

Large non-retractile polyps (≥10 mm in length by 4 mm in width) are situated irregularly apart at distances of 2–10 mm. Tentacle sclerites include flattened elongated bodies (0.7–0.9 mm in length), clubs (0.09–0.14 mm in length) with plump or elongated heads, and small straight spindles (≥0.12 mm in length). Polyp body wall sclerites are clubs (0.11–0.14 mm in length), warty club-like spindles (≥0.15 mm in length), capstans (0.15–0.17 mm in length) with girdled warts and plump terminal tufts, and spindles (0.15–0.17 mm in length). The coenenchyme consists of leafy clubs (0.08–0.09 mm in length) and sparse warty clubs (0.13–0.15 mm in length), both with well-developed heads and blunt warty handles, and warty spindles (13 mm in length) and capstans (0.15–0.17 mm in length).

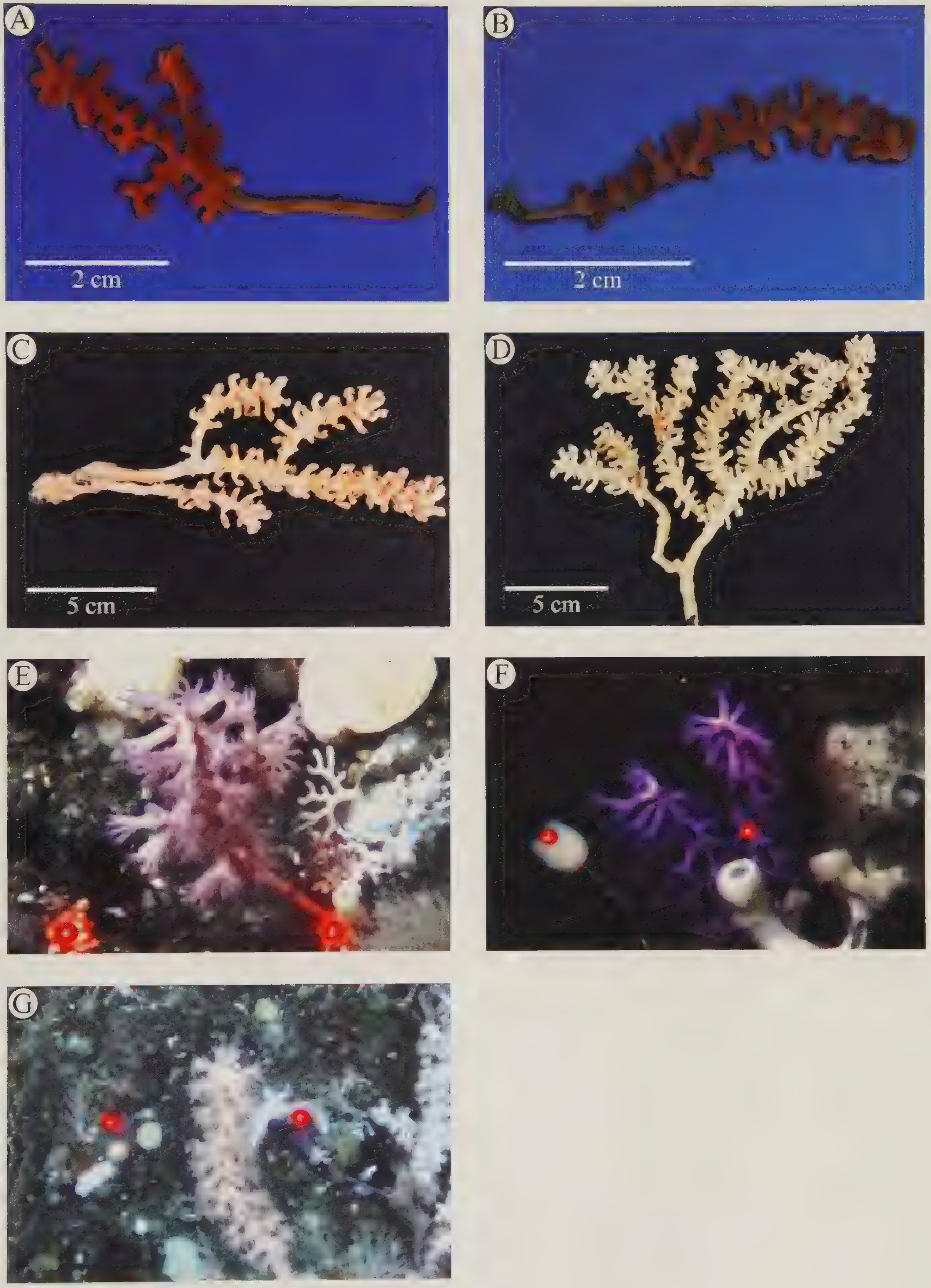
Color of colonies in life is light orange, sometimes with purple hues and light purple to brilliant violet. Specimens preserved in ethanol are light orange.

Remarks Associated organisms include ophiuroids.

Distribution Locally common. In Alaska – the Aleutian Islands from the Islands of Four Mountains to Amchixtam Chaxsxii (Fig. 8-6). Elsewhere – Sea of Japan, Sea of Okhotsk, and a single record identified by Matsumoto et al. (2019) from off Cape Flattery, Washington. However, that specimen more closely resembles *C. beringi* and not *C. japonica* so we have tentatively listed it as such until it can be re-examined.

Habitat In Alaska – found in scattered patches sometimes densely (up to 15 colonies/m^2 in Adak Canyon) where it attaches to cobbles and pebbles, rarely on bedrock and boulders. Collected specimens range in depth from 57 to 2095 m but video observations (senior author, personal observ.) indicate this species ranges to depths of 2210 m in the central Aleutian Islands. Elsewhere – found in areas of pebbles, sand, and silt at depths between 228 and 900 m.

Photos A) A fresh whole *C. japonica* colony (CAS 234581) collected on Amchixtam Chaxsxii, central Aleutian Islands, at a depth of 399 m. B) A fresh whole *C. japonica* colony (CAS 234582) collected in northern Amchitka Pass, central Aleutian Islands, at a depth of 822 m. C) A preserved (in ethanol) whole *C. japonica* colony (USNM 1004642) collected north of Kanaga Island, central Aleutian Islands, at a depth near 300 m. D) A preserved (in ethanol) whole *C. japonica* colony (USNM 1006154) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 280 m. E–G) *Calcigorgia japonica* colonies observed on Amchixtam Chaxsxii at depths of 557 m (E), 862 m (F), and 862 m (G). The distance between the red laser marks in photos E–G is 10 cm.


A
2 cm
B
2 cm
C
5 cm
D
5 cm
E
F
G

5. *Calcigorgia japonica* Dautova, 2007 (continued)

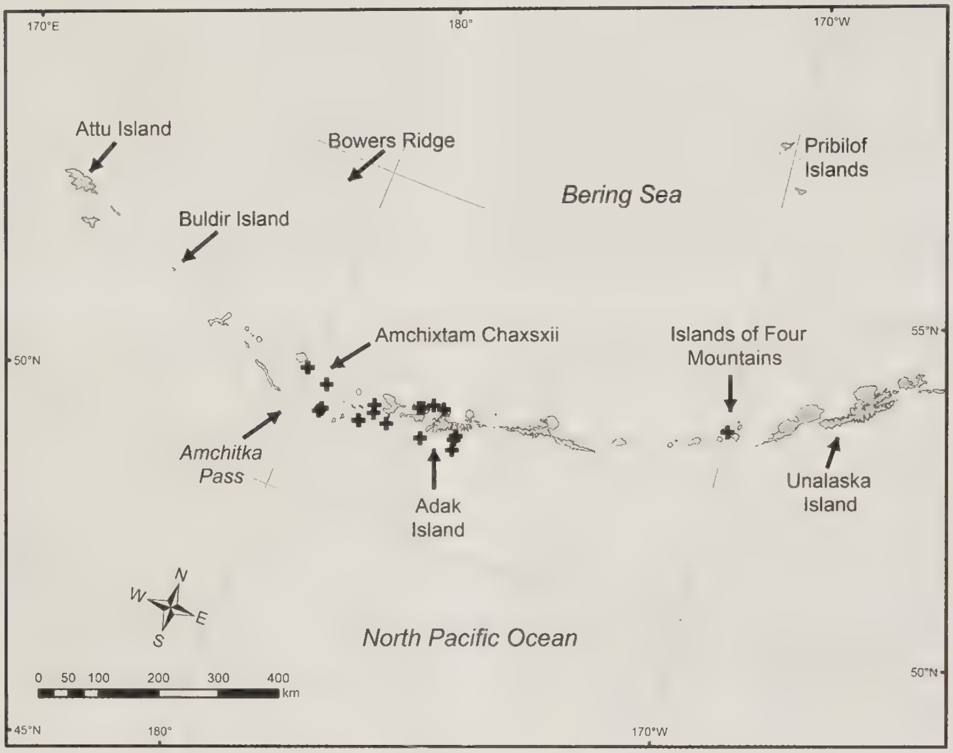

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Amchixtam Chaxsxii
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 8-6

A map of the Aleutian Islands showing the distribution of *Calcigorgia japonica* (**+**) in Alaska waters.

6. *Calcigorgia matua* Dautova, 2018

Description The Alaska specimen, the largest known, is planar and has dimensions 14 cm in height and 15 cm in width, with branches that are 4–5 mm in diameter. Branching is irregular and to the 5th order. The Alaska specimen was collected without its holdfast but it is likely stout and strong. The coenenchyme is quite thick and easily peels off in sheets in the preserved specimen. Prominent tubular calyces are relatively widely spaced and situated irregularly around all sides of the branches. Polyps are cylindrical, arranged spirally around the branches, 2–3 mm in height by 1 mm in width, and slightly widened near the base. Tentacle sclerites are scales (0.12 mm in length) with a few simple tubercles; polyp sclerites are small clubs (≥0.10 mm in length) with simple tubercles; and coenenchyme sclerites are capstans, small spindles, and cylinders (≥0.12 mm in length) with simple or complex tubercles.

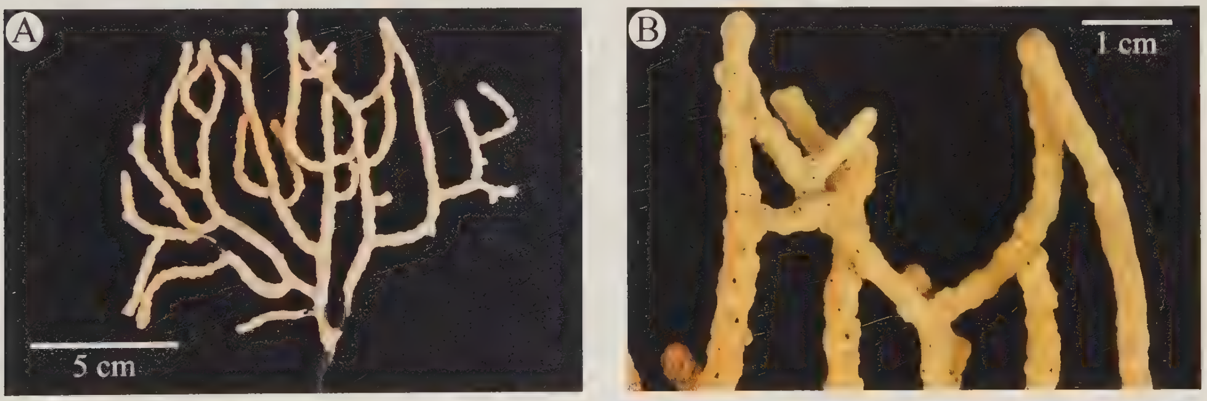
The skeletal axis is woody but relatively stiff, and light black in color. The coenenchyme in the dried specimen is light orange with a yellow hue.

Remarks Matsumoto et al. (2019) indicate that this species most closely resembles *C. beringi,* differing mainly in having very short distinct clubs in the polyps, which are entirely lacking in *C. beringi*. Our observations, however, are that this species superficially most closely resembles two other corals in this group, *Alaskagorgia aleutiana* and *Cryogorgia koolsae* Williams, 2005.

Distribution Rare. In Alaska – known from only a single specimen collected west of Semisopochnoi Island, western Aleutian Islands (Fig. 8-5). Elsewhere – Sea of Okhotsk including the Kurile Islands (Russia).

Habitat In Alaska – attaches to hard substrate at depths around 300 m. Elsewhere – found in areas of sand and pebbles at depths between 300 and 900 m.

Photos A) A dried whole (except the holdfast) *C. matua* colony (USNM 1006226) collected southwest of Semisopochnoi Island, western Aleutian Islands, at an approximate depth of 296 m. B) A close-up view of the same specimen in photo A.



7. *Calcigorgia spiculifera* Broch, 1935

Description (Adapted from Matsumoto et al., 2019) Colonies are mostly planar or flabellate but some colonies are slightly bushy. Maximum colony size is about 50 cm in height and width. Branching is a mixture of openly lateral and irregularly dichotomous. Typical branch width is 6–8 mm, up to 5th order branching, and large colonies may have up to 65 branch tips.

The cylindrical polyps are up to 3 mm in height and 1.6 mm in width. The polyps are armed with tuberculate spindles (0.18–0.3 mm in length), more or less club-like, and integrating with the spindles (≥0.36 mm in length) of the polyp body. The coenenchyme contains small capstans, double heads, and cylinders (0.07–0.11 mm in length) with indistinct waists integrating with belted spindles (0.12–0.15 mm in length), a few crosses, and irregular forms.

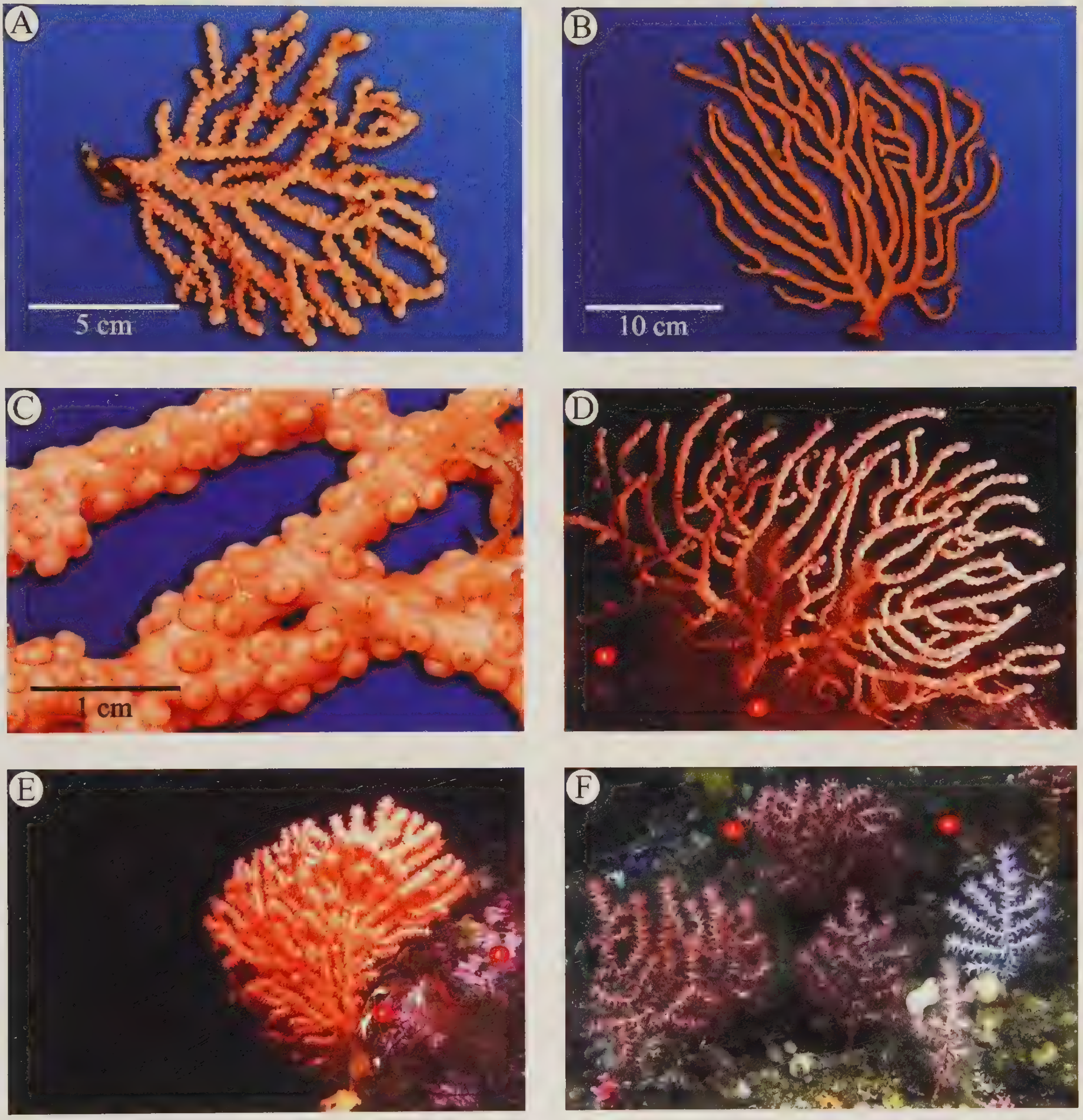
The axial skeleton is black to dark brown, woody, and flexible. The coenenchyme is light to dark orange in color but occasionally white in the eastern Gulf of Alaska and northern British Columbia.

Remarks This species differs from all congeners in having polyp spindles and club-like sclerites instead of real clubs. This is the most common shallow-water (<50 m depth) octocoral in Alaska and consequently its ecology has been relatively well studied (Stone and Wing, 2001; Stone et al., 2017). It is a slow-growing octocoral (linear growth rate of 6.0 mm/year) and, despite its small size, would require 60 years or more to grow to maximum size (Stone et al., 2017). This species is a gonochoristic (i.e., separate sexes) brooder that appears to spawn at least annually. The species harbors a diverse suite of ophiuroids. The coenenchyme and sclerites are principally composed of high-magnesium calcite (9.5–10.4 mol% $MgCO_3$) with minute amounts of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Locally common. In Alaska – the eastern Gulf of Alaska including the inside waters of Southeast Alaska and the Aleutian Islands from north of the Krenitzen Islands to west of Kiska Island (Fig. 8-7). Elsewhere – Sea of Okhotsk (Sakhalin and Kurile Islands) and northern Vancouver Island and Queen Charlotte Sound, British Columbia.

Habitat In Alaska – found in small discrete patches, often in areas of high to moderate current where it attaches to bedrock, boulders, cobbles, and occasionally bivalve shells. Collected specimens range in depth from 12 to 441 m but video observations in the central Aleutian Islands (Stone, 2014) indicate that this species ranges to depths of 512 m there. Elsewhere – the type specimen was collected in the Sea of Okhotsk at a depth of 165 m. Found on bedrock at depths between 158 and 440 m (Sea of Okhotsk) and between 40 and 284 m (British Columbia).

Photos A) A fresh whole *Calcigorgia spiculifera* colony (USNM 1484124) collected south of Semisopochnoi Island, central Aleutian Islands, at a depth of 27 m. B) A fresh whole *C. spiculifera* colony (USNM 1484107) collected near Adak Island, central Aleutian Islands, at a depth of 24 m. C) A close-up view of a fresh *C. spiculifera* specimen (USNM 1484112) collected south of Semisopochnoi Island at a depth of 22 m. D) A *C. spiculifera* colony photographed south of Semisopochnoi Island at a depth of 24 m. Polyps are fully retracted. E) A *C. spiculifera* colony photographed north of Little Tanaga Island, central Aleutian Islands, at a depth of 25 m. Polyps are fully expanded. F) A patch of small *C. spiculifera* colonies, including the white morph, on Shutter Ridge, eastern Gulf of Alaska, at a depth of 88 m. The distance between the red laser marks in photos D–F is 10 cm.


A
5 cm
B
10 cm
C
1 cm
D
E
F

7. *Calcigorgia spiculifera* Broch, 1935 (continued)

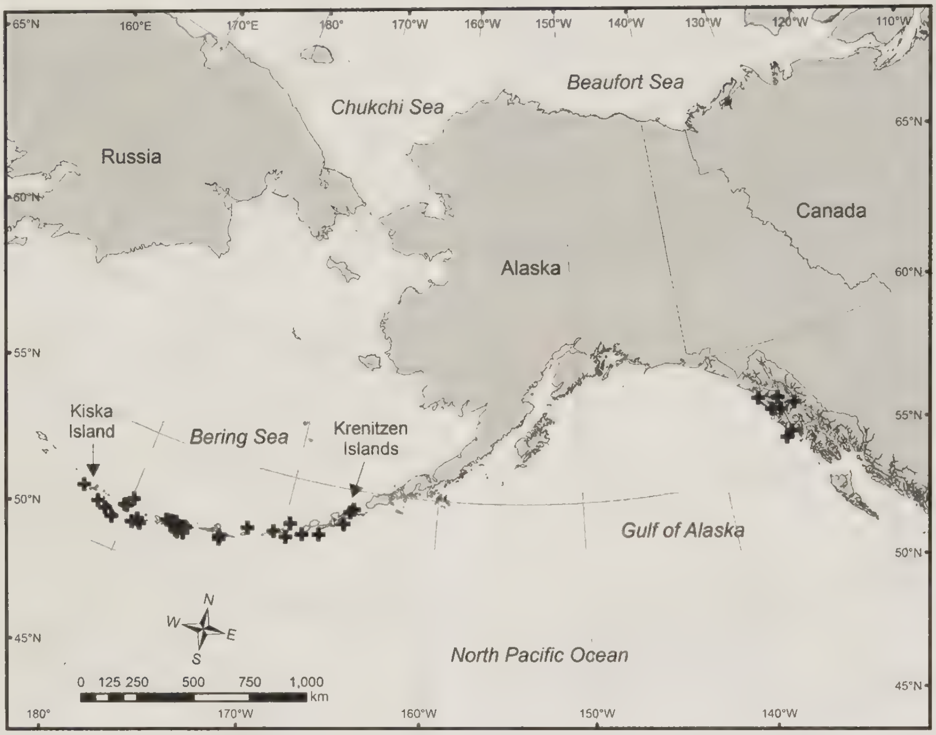

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
Canada
Alaska
60°N
55°N
50°N
45°N
Kiska Island
Bering Sea
Krenitzen Islands
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
180°
170°W
160°W
150°W
140°W

Figure 8-7

A map of the North Pacific Ocean showing the distribution of *Calcigorgia spiculifera* (+) in Alaska waters.

8. *Cryogorgia koolsae* Williams, 2005

Description (Adapted from Williams, 2005) Colonies are upright, stout, branching in one plane, and typically candelabra-like. Branching is irregular (lateral) and relatively sparse; the largest specimen has only 22 branch tips and 4th order branching. Terminal branches are elongate and slightly clavate. These specimens measure up to 44 cm in height and 19.5 cm in width, often with the lower 31–41% of the colony unbranched. Monopodial colonies are typically less than 18 cm in height and apparently have not reached the branching stage yet (see photos F and G on next page). Holdfasts are cup-shaped, covered with coenenchyme, but relatively easy to detach from the substrate (i.e., when collecting colonies the holdfast will detach before the axis will tear). The axial skeleton is woody, quite flexible, nearly impossible to tear, and dark brown to black in color. The coenenchyme is thick, easily removed from the axial skeleton in sheets, bright to medium orange in life, slightly paler orange in ethanol, and yellow when dried.

A highly variable section of the stalk is naked or barren (devoid of polyps); polyps may start near the base or not until the first secondary branches. The naked section of the stalk is often covered with filamentous brown algae in shallow-water specimens (less than about 80 m depth), and occasionally also covered with demosponges and hydroids. The polyps are retractile but exhibit various states of exsertion in preserved specimens. Polyps are large (up to 8 mm in length when fully expanded, see photo F), irregularly cover most of the branch surfaces, and are much lighter in color than the coenenchyme, almost white, in situ (see photo F on next page). The polyp mounds (not true calyces) are hemispherical to cone-shaped or somewhat cylindrical.

Coenenchymal sclerites of the polyp-bearing branches, branch tips, and polyp mounds are of several different forms: foliates or leaf-clubs (0.07–0.12 mm in length); seven- and eight-radiates (0.07–0.10 mm in length); clavate forms (0.08–0.15 mm in length); crosses (0.10–0.11 mm in length); and modified radiates, cylinders, and spindles (0.07–0.15 mm in length). Sclerites are small for the family; anthocodial sclerites are lacking, and all sclerites are colorless.

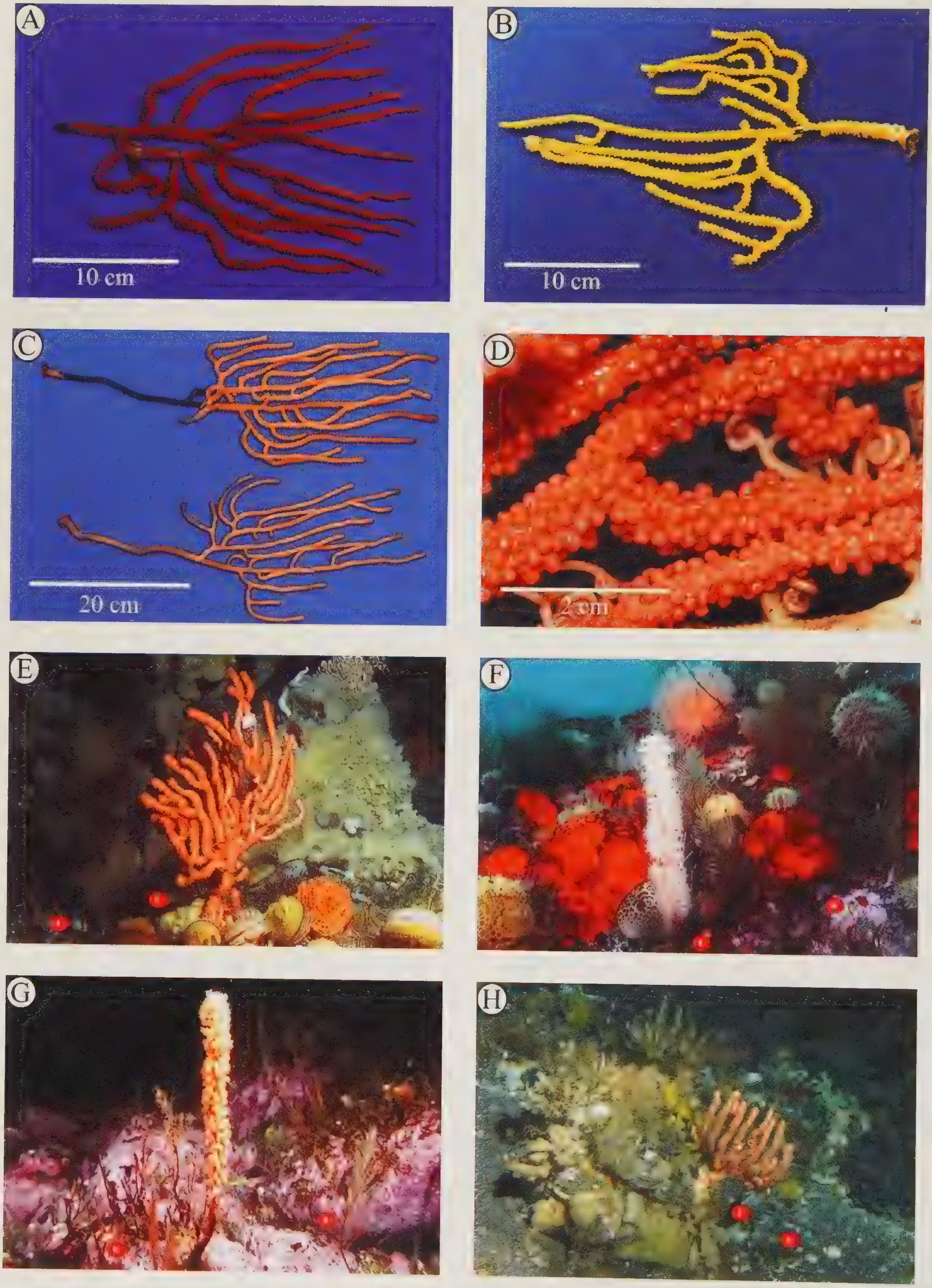
Remarks Larger colonies in shallow water often serve as an elevated perch for the brittle star *Gorgonocephalus eucnemis* and can also be heavily populated by caprellid amphipods. The microbial ecology of this species has been studied from specimens collected in the central Aleutian Islands (Gray et al., 2011).

Distribution Uncommon. In Alaska – known only from the Aleutian Islands (Amukta Pass to south of Buldir Island) including Petrel Bank (Fig. 8-8). Elsewhere – not reported.

Habitat Occurs on hard rock including bedrock, boulders, cobbles, and pebbles in areas of moderate current, and at depths between 18 and 412 m, but rarely deeper than 150 m.

Photos A) A fresh whole (except the holdfast) *Cryogorgia koolsae* colony (USNM 1484133) collected north of Kasatochi Island, central Aleutian Islands, at a depth of 65 m. B) A dried whole *C. koolsae* colony (USNM 1484130) collected south of Adak Island, central Aleutian Islands, at a depth of 54 m. C) Two of the largest known *C. koolsae* specimens (USNM 1011357; whole colonies; fresh) collected on Petrel Bank, central Aleutian Islands, at a depth of 175 m. D) A close-up view of a fresh *C. koolsae* specimen (USNM 1484131) collected north of Adak Island, central Aleutian Islands, at a depth of 70 m. E) A *C. koolsae* colony observed near Kagalaska Island at a depth of 100 m. F) A monopodial *C. koolsae* colony with polyps fully extended, photographed south of Semisopochnoi Island, central Aleutian Islands, at a depth of 25 m. G) A monopodial *C. koolsae* colony with polyps mostly retracted, photographed north of Little Tanaga Island, central Aleutian Islands, at a depth of 25 m. H) A *C. koolsae* colony observed northwest of Adak Island, central Aleutian Islands, at a depth of 130 m. The distance between the red laser marks in photos E–H is 10 cm.

8. *Cryogorgia koolsae* Williams, 2005 (continued)


A
10 cm
B
10 cm
C
20 cm
D
2 cm
E
F
G
H

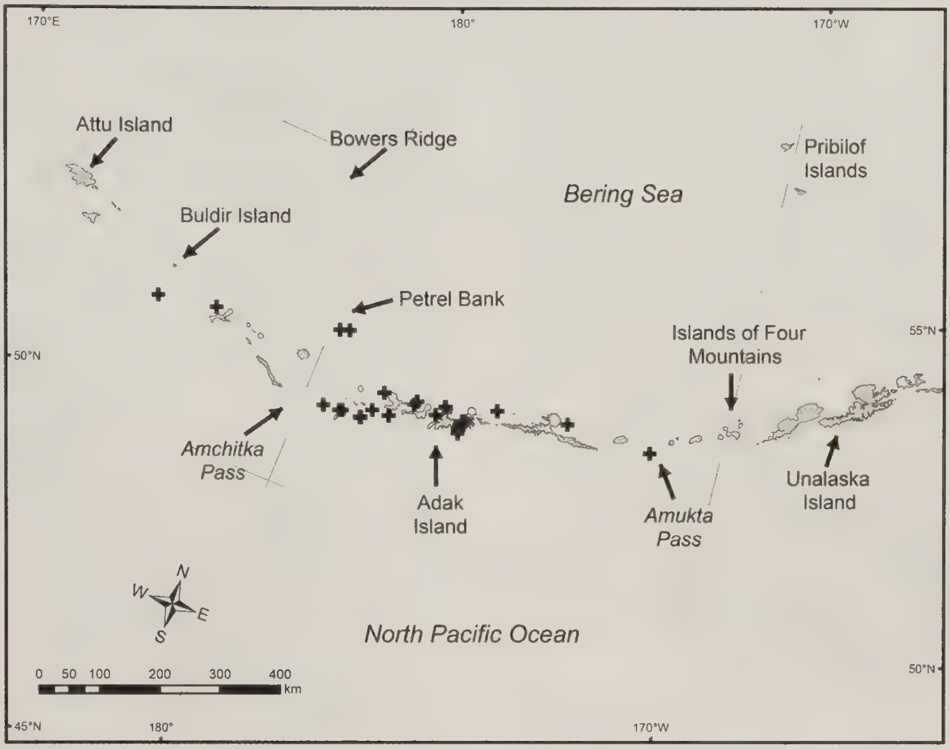

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 8-8

A map of the North Pacific Ocean showing the distribution of *Cryogorgia koolsae* (+) in Alaska waters.

9. *Elenanthus* cf. *violaceus*

Description (Adapted from Sanamyan and Sanamyan, 2020) *Elenanthus violaceus* Sanamyan and Sanamyan, 2020 was recently described from specimens collected near the Kurile Islands (Russia). Molecular analysis confirmed that the specimens represented a novel genus and species of stoloniferan. Colonies in the genus *Elenanthus* are small, typically only several centimeters in diameter, in the form of a low pad with slightly tucked edges, and attached to the substrate by the middle part of the lower surface. The holdfast is very short but thick, and weakly attached. All polyps are the same, located evenly over the entire upper surface of the colony, tightly packed together, and fully retractile. The surface of the coenenchyme with retracted polyps is perfectly smooth with small elevations.

Colonies are small (up to 30 mm in length and 12 mm in width). Fully expanded polyps are up to 5 mm in length. The most important distinguishing feature of this species and genus is the complete absence of sclerites in the tissues. Color of colonies in life is a uniform bright purple but turns brown in ethanol.

The Alaska specimens conform almost perfectly with the description and photos provided in the published account (Sanamyan and Sanamyan, 2020). Colonies are relatively large (up to 8–10 cm in length), typically elongate (up to 3–4 cm in width), and with up to 36 polyps. Polyps are larger than in the original description (up to 8 mm in length when fully expanded). The Alaska specimens have not yet been examined to verify that they too completely lack sclerites so accordingly we list the specimen as *Elenanthus* cf. *violaceus*. Although colonies are small, they are quite conspicuous due to their brilliant magenta to fuchsia color.

Distribution Uncommon. In Alaska – known from four collected specimens and many video observations in the central Aleutian Islands (Amlia Island to Amchixtam Chaxsxii) including Petrel Bank (Fig. 8-9). Elsewhere – the type specimens were collected near Matua Island (Kurile Islands, Russia) in the Sea of Okhotsk, Northwest Pacific Ocean.

Habitat In Alaska – occurs singly or in small patches (up to five colonies together) on bedrock, boulders, cobbles, and mollusk shell including the Alaska jingle (*Pododesmus macrochisma*) at depths between 22 and

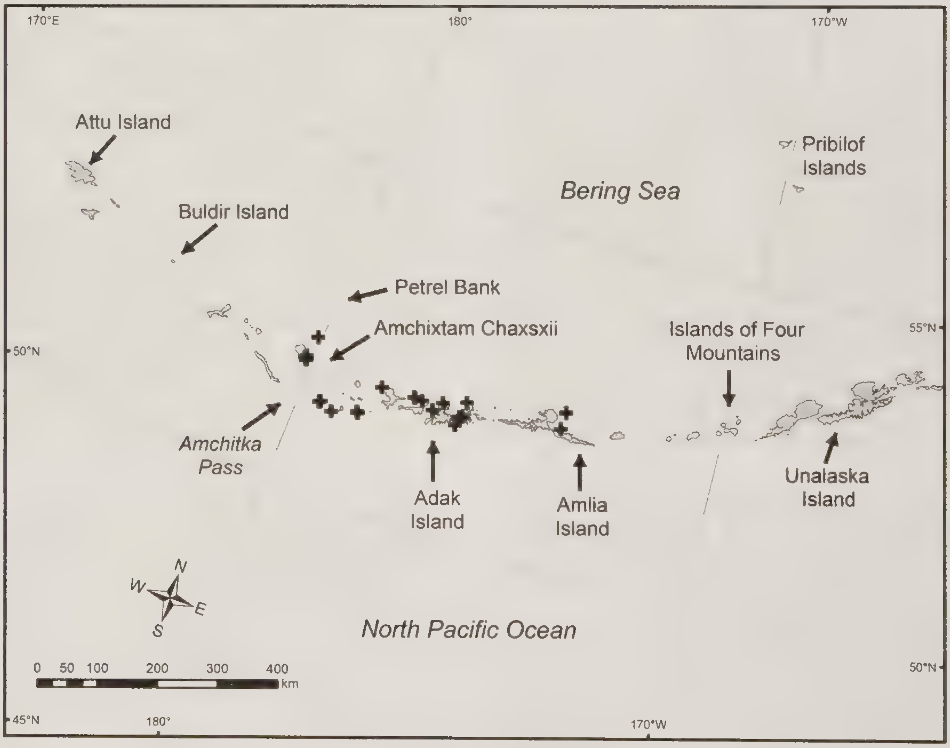
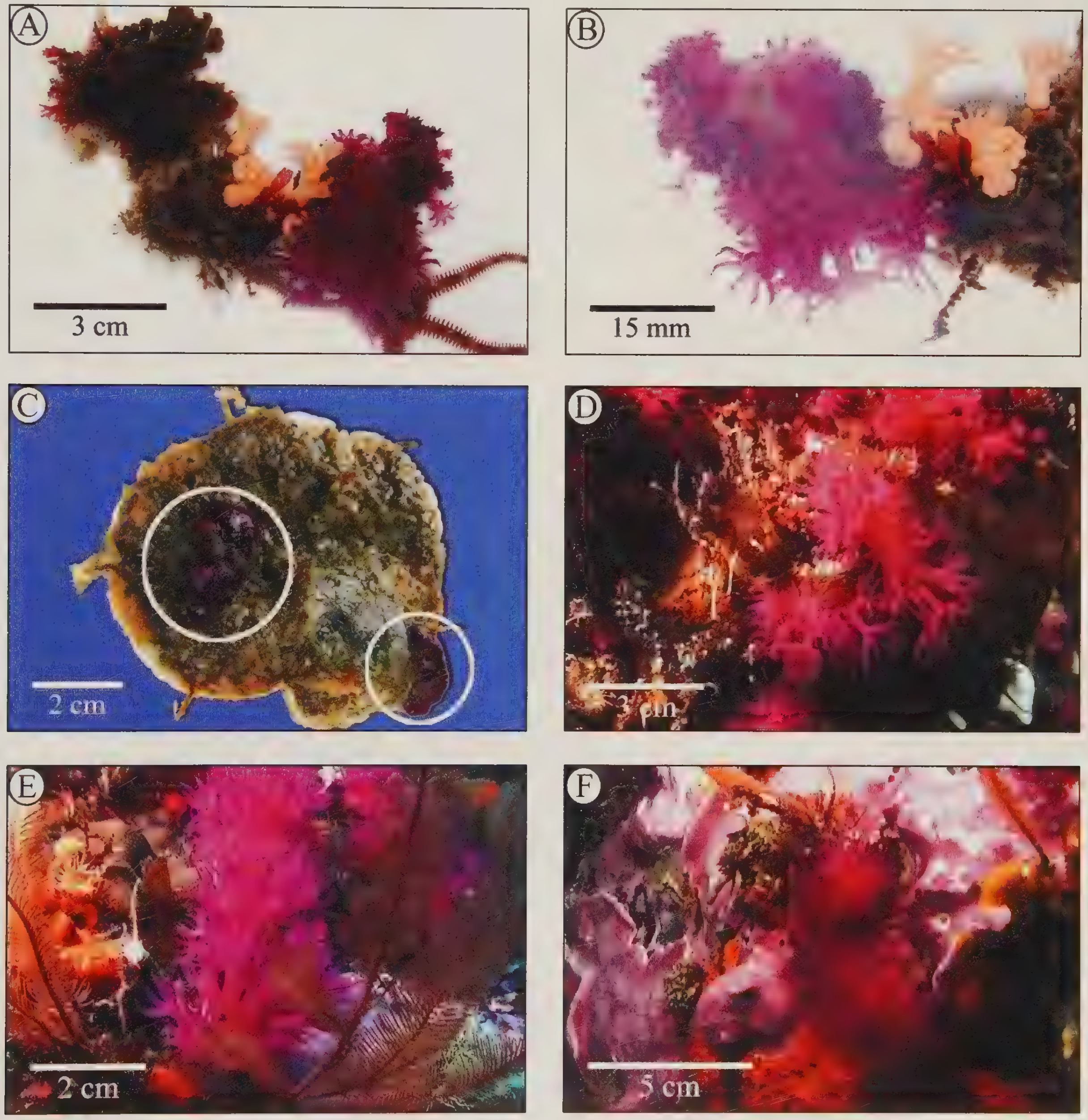


Figure 8-9

A map of the Aleutian Islands showing the distribution of *Elenanthus* cf. *violaceus* (+) in Alaska waters.

352 m. Elsewhere – occurs singly or in small patches on bedrock at depths between 13 and 14 m.

Photos A) A fresh whole *E.* cf. *violaceus* colony (CAS 234583), with some polyps extended, collected near Bobrof Island, central Aleutian Islands, at a depth of 25 m. An unidentified orange *Clavularia* species, possibly *Clavularia* sp. A, is pictured at center. B) A close-up view of the same specimen in photo A. C) Two fresh whole *E.* cf. *violaceus* colonies (indicated by the white circles; CAS # pending) with polyps retracted, collected near Kagalaska Island, central Aleutian Islands, at a depth of 100 m. The colonies are growing on an Alaska jingle. D) An *E.* cf. *violaceus* colony (CAS # pending) just before collection near Bobrof Island, central Aleutian Islands, at a depth of 25 m. The specimen in photo A is visible at the top of the photograph. E) An *E.* cf. *violaceus* colony photographed near Bobrof Island at a depth of 27 m. F) An *E.* cf. *violaceus* colony photographed near Bobrof Island at a depth of 24 m.



CHAPTER 9

Family Paramuriceidae

(Adapted from McFadden et al., 2022) Paramuriceidids are octocorals; they almost always have a proteinaceous skeletal axis that is hollow with a wide-chambered central core. Colonies are erect and mostly branched but may be planar or bushy. The coenenchyme is typically very thin. Polyps are monomorphic and are either retractile into prominent calyces or, if non-retractile, possess a polyp wall heavily armored with spindles, giving the appearance of a cylindrical calyx. Calyx sclerites are thornscales or spindles that are different from coenenchymal sclerites.

Of the 25 known genera of Paramuriceidae, only two are found in Alaska waters: *Acanthogorgia* (two species) and *Muriceides* (two species). Both genera were formerly included in the now defunct suborder Holaxonia. The distribution of the two genera in Alaska is limited to the Aleutian Islands (Fig. 9-1). They are mostly deep-water fauna occupying depths between 78 and 2087 m and grow directly on hard rock (bedrock, boulders, cobbles, pebbles, and siltstone).

All species of paramuriceidids in Alaska have definitive taxonomy except *Acanthogorgia* sp., which was revealed as a separate species from *A. spissa* Kükenthal, 1908 using molecular genetics (Thoma, 2013). Additionally, *Muriceides cylindrica* Nutting, 1912 is known from only two specimens that were poorly cataloged after collection and description. All specimens collected in Alaska waters that fit the description of either *A. spissa* or *M. cylindrica* should be retained and properly preserved for morphological and molecular studies.

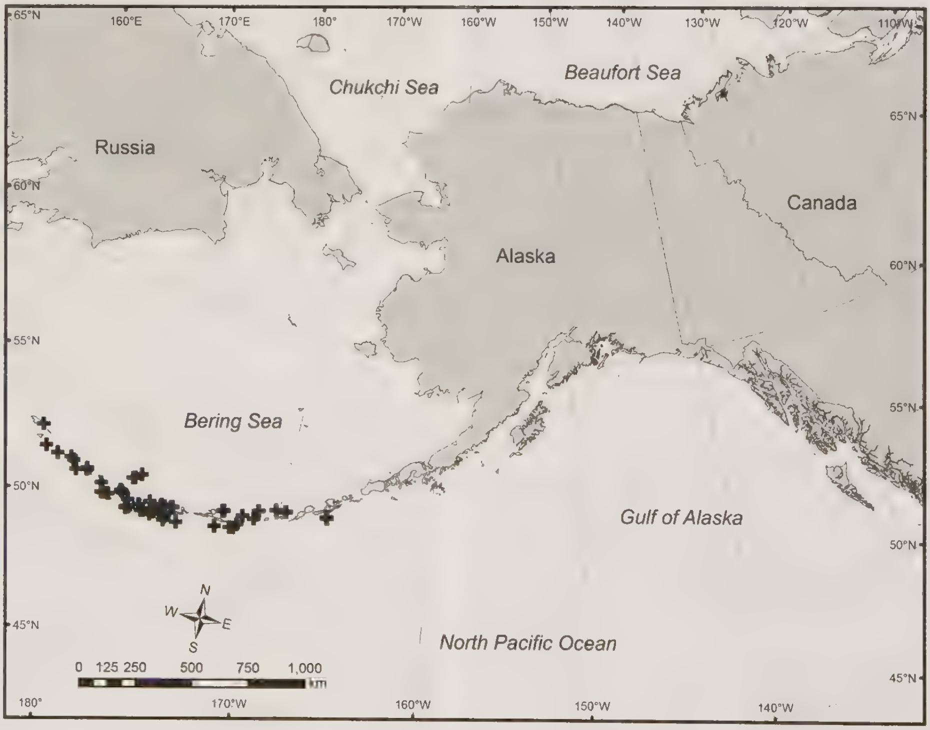

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
60°N
55°N
Bering Sea
Gulf of Alaska
50°N
45°N
N
W
E
S
North Pacific Ocean
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W

Figure 9-1

A map of the North Pacific Ocean showing the distribution of corals in the family Paramuriceidae (+) in Alaska waters.

1. *Acanthogorgia spissa* Kükenthal, 1908

Description (Adapted from Kükenthal, 1908) Colonies are almost always planar, rarely bushy, and up to 50 cm in height and 50 cm in width. Colonies have very dense branching, with numerous side branches emanating from one side of the branching plane at an acute angle. Branches and side branches are somewhat wavy and bent; all branches except primaries are thin and delicate. The polyps are non-retractile, densely crowded, basally preferring the branching plane, with a prominent crown of sharp spines (actually spindles) around the top just below the base of the tentacles. The polyps are up to 2.5 mm in length, and the upper ends of the heavily spined sclerites of the polyps stand out of the surface creating eight longitudinal ribs up to 0.8 mm in length. The spined spindles are up to 0.9 mm in length; their round spines stand out only somewhat above the head of each polyp and merge slowly into the slightly bent, widely spined lower leg. The tentacles contain acanthose plates, which are wide, up to 0.12 mm in length, and often nearly club-shaped. Within the coenenchyme are slim, bent, widely spined sclerites of approximately 0.3 mm in length and single three-rayed and smaller forms of about 0.06 mm in length, with a middle shaft and at both ends three thick, warty rays.

Holdfasts are irregularly shaped, covered with coenenchyme, and strongly attached to the substrate (i.e., when collecting colonies the axis will almost always tear before the holdfast detaches). The skeletal axis is woody, pliable, and a dark brown to light black in color. The coenenchyme is thin and typically olive-green, occasionally with a golden hue in life, but slightly faded in color when preserved.

Remarks This species hosts an extremely diverse suite of associates including amphipods (caprellids, pleustids, and stenothoidids), isopods (antarcturids, munnids, and eurycopids), polychaetes (family Syllidae), and nemerteans (Watling and Stone[7]). Larger colonies are occasionally used as refuge by Verrill's king crab (*Paralomis verrilli*). The coenenchyme and sclerites are principally composed of high-magnesium calcite (7.6 mol% $MgCO_3$) with minute amounts of aragonite and calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Rare but locally common (Fig. 9-2). In Alaska – central Aleutian Islands. Known only from five specimens collected south of Adak Island, including Adak Canyon, but also observed on video footage collected in southern Amchitka Pass (senior author, personal observ.). Elsewhere – known only from the type locality in Uruga Channel, Japan, at a depth of about 55 m. Note: the collection site was in the immediate location of a fishing port so we suspect that the specimen, given its apparent disparate bathymetric displacement from the known depth range, might have been translocated to the collection site during the process of cleaning fishing gear.

Habitat In Alaska – scattered patches on bedrock and large boulders and often on siltstone ridge crests grow-

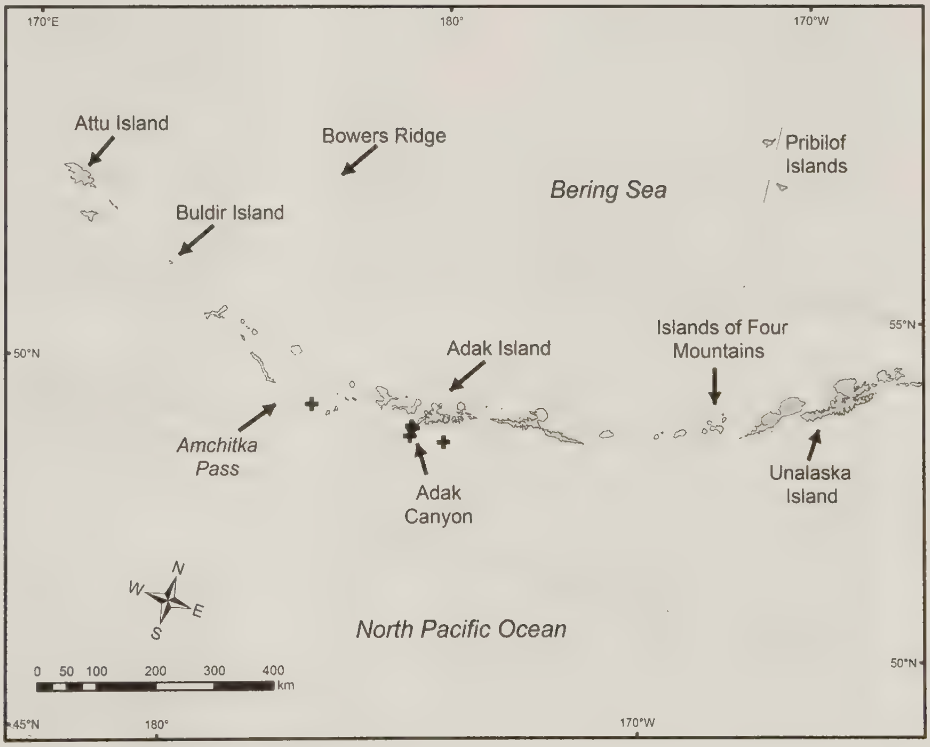
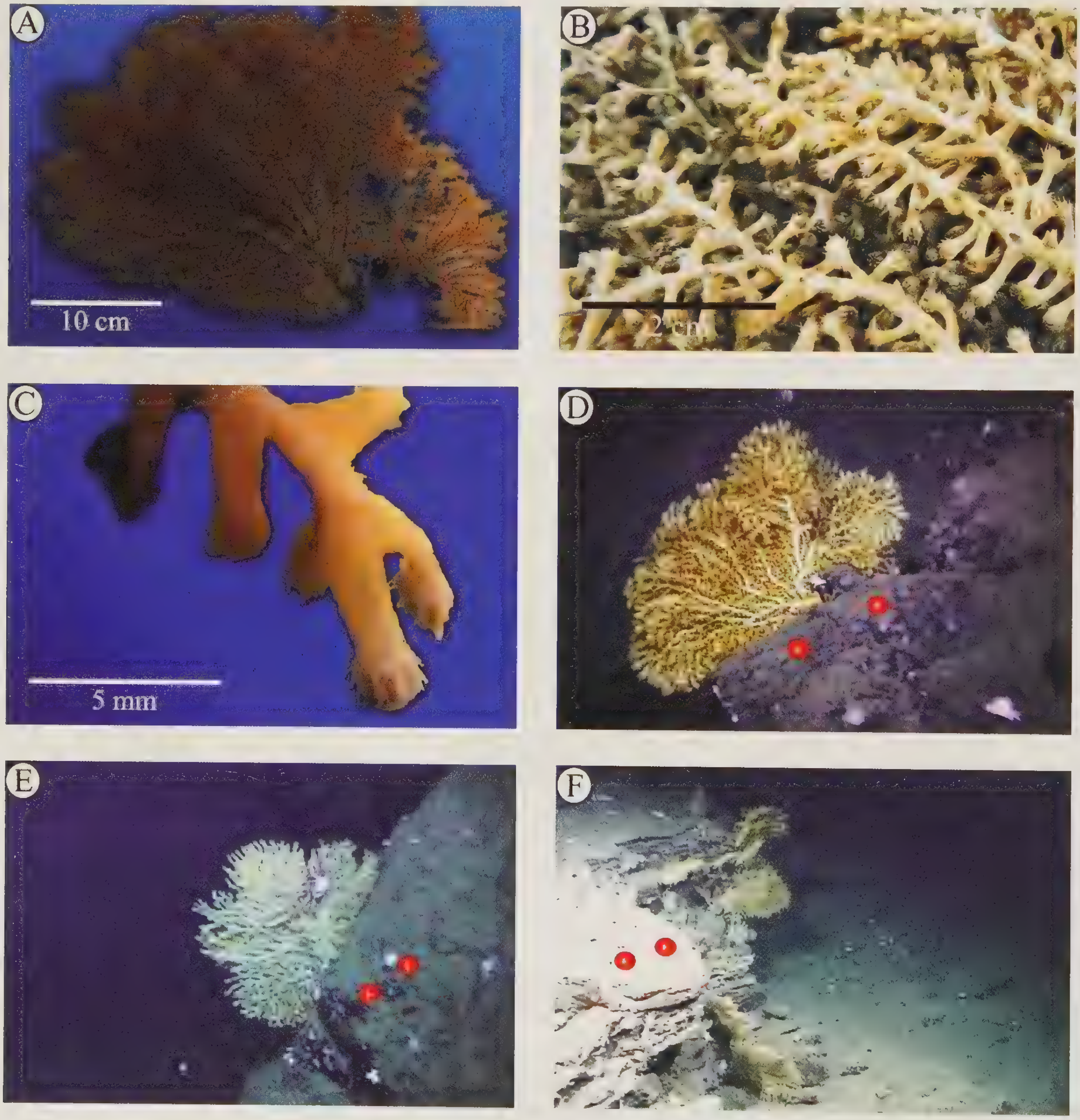


Figure 9-2

A map of the Aleutian Islands showing the distribution of *Acanthogorgia spissa* (+) in Alaska waters.

ing in linear rows. Collected specimens range in depth from 1692 to 1728 m, but video observations in the central Aleutian Islands (senior author, unpubl. data) indicate this species ranges at depths between 1092 and 2087 m. Co-occurs with *Acanthogorgia* sp. in the same patches where their depth ranges overlap. Elsewhere – no data available.

Photos A) A dried whole *A. spissa* colony (USNM 1484165) collected in Adak Canyon in the central Aleutian Islands at a depth of 1714 m. B) A close-up view of the same specimen in photo A. C) A close-up view of the polyps on the same specimen in photo A. D) An *A. spissa* colony observed in Adak Canyon at a depth of 1894 m. E) An *A. spissa* colony observed in Adak Canyon at a depth of 1896 m. A Verrill's king crab uses the colony as refuge. The distance between the red laser marks in Photos D and E is 10 cm. F) A patch of *A. spissa* colonies on a siltstone ridge crest in Adak Canyon at a depth of 1958 m. The distance between the red laser marks is 20 cm.



2. *Acanthogorgia* sp.

Description This species appears similar to *A. spissa* but molecular analysis (Thoma, 2013) indicates enough differentiation to warrant a separate designation at this time. Colonies are bushier than *A. spissa*, rarely planar, and up to 25 cm in height and 25 cm in width. Color is typically olive-green with a golden hue.

Remarks The World Register of Marine Species lists 58 valid species of *Acanthogorgia*. They are found in all oceans in both shallow and deep waters. However, they are rare in the northern North Pacific Ocean and represented only by *A. spissa* and this species. This species is also similar to *A. paradoxa* Nutting, 1912, which is known only from the East China Sea (174–247 m depth) and Suruga Gulf, Japan (198 m depth). Several specimens identified only as *Acanthogorgia* sp. have been collected from northern British Columbia at depths between 876 and 1460 m and may be the same species presented here.

This species hosts a rich suite of associates, including caprellid and stenothoidid amphipods and munnid and antarcturid isopods (Watling and Stone[7]).

Distribution Rare but locally common. In Alaska – central Aleutian Islands from southwest of Amlia Island to Amchixtam Chaxsxsii (Fig. 9-3). Elsewhere – *Acanthogorgia* sp. has been reported in the northern North Pacific Ocean only from off northern Vancouver and Queen Charlotte Islands, British Columbia.

Habitat In Alaska – scattered patches on bedrock and large boulders and often on siltstone ridges. Collected specimens range in depth from 843 to 1692 m. Co-occurs with *A. spissa* in the same patches where their depth ranges overlap. Elsewhere – *Acanthogorgia* sp. have been reported at depths between 876 and 1468 m in northern British Columbia and at depths between 372 and 480 m on the Emperor Seamounts in the central-west North Pacific Ocean.

Photos A) A large portion of a dried *Acanthogorgia* sp. colony (USNM 1484162) collected southwest of Amlia Island, central Aleutian Islands, at a depth of 843 m. B) A close-up view of the same specimen in photo A. C) An *Acanthogorgia* sp. colony (J2100-4-1; indicated

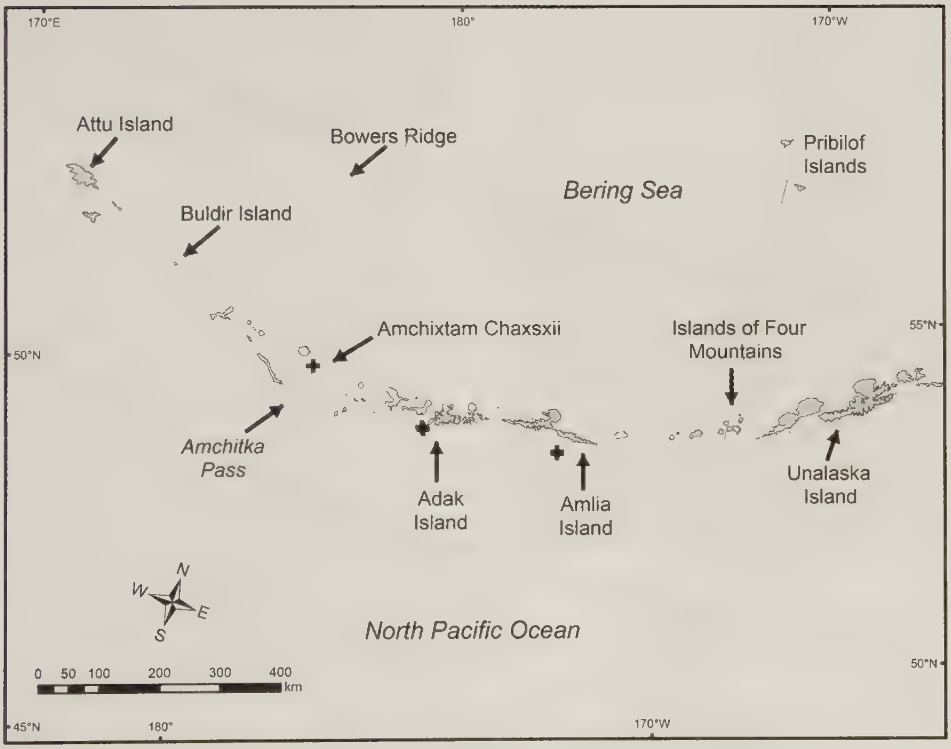
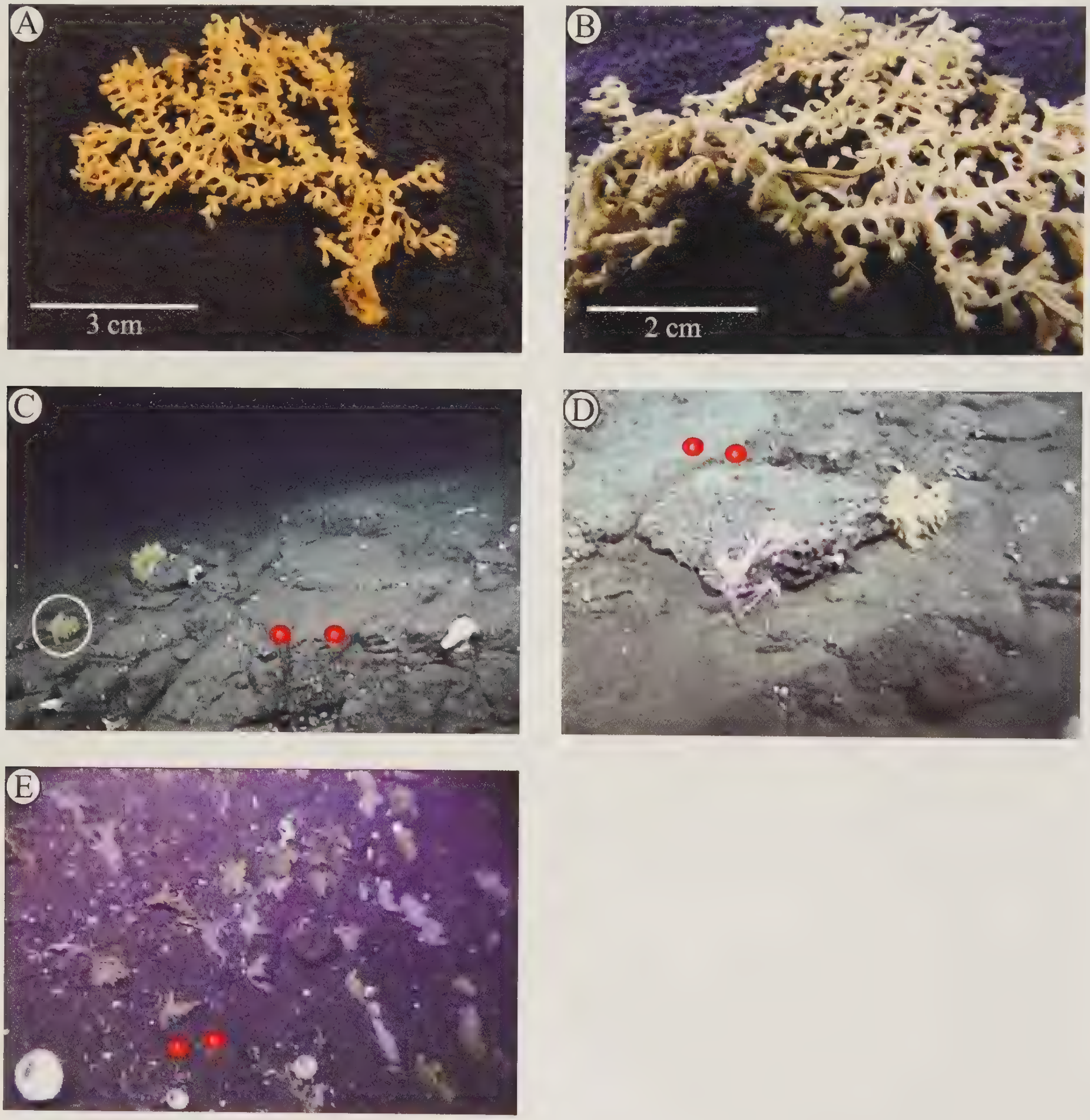

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Amchixtam Chaxsxii
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amlia Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 9-3

A map of the Aleutian Islands showing the distribution of *Acanthogorgia* sp. (+) in Alaska waters.

by the white circle) collected in Adak Canyon, central Aleutian Islands, at a depth of 1692 m. The distance between the red laser marks is 20 cm. D) A close-up view of the same colony in photo C. The distance between the red laser marks is 10 cm. E) A sloped habitat of siltstone and sand in Adak Canyon at a depth of 1712 m, with both *Acanthogorgia* sp. and *A. spissa* present. The distance between the red laser marks is 20 cm.



3. *Muriceides cylindrica* Nutting, 1912

Description (Adapted from Nutting, 1912) The holotype colony is flabellate but quite straggly with an obvious main stalk and two secondary branches originating close to the base. The colony is 15 cm in height, quite flexible, and delicate in appearance. The branches are somewhat flattened in one plane, and branching is irregular and to the 3rd order only. The photo of the holotype (photo B) does not show a holdfast but the axial skeleton is woody, quite fibrous, and brown in color. The color of the coenenchyme in the ethanol-preserved holotype is a dull yellowish-brown; the color in situ is unknown.

Calyces are irregularly distributed on the branches but are generally lateral and distributed more on all sides nearer the distal ends. They appear to be alternately positioned and generally sparse and well spaced (≥2 mm). The calyces are tubular, typically 2.0 mm in height and 1.7 mm in diameter, and surmounted with a relatively large polyp. The polyps are apparently not completely retractile; most are resting above the margin of the calyx in the preserved specimen.

The sclerites are exclusively spindles and are small for the family. The spindles of the calyx walls are longer and relatively more slender than those of the coenenchyme, which are often terete forms and are densely/closely tuberculated. The coenenchyme is covered with small, stout, warty spindles irregularly disposed but positioned longitudinally. The polyp crown is very strong and composed of several transverse rows of small spindles concentrated in a conspicuous band. The operculum is robust and composed of numerous small spindles arranged *en chevron* on basal parts of the tentacles. All sclerites are colorless.

Remarks The information provided with the original species description is vague and apparently incomplete. This species is described from two specimens collected during the 1906 Northwest Pacific Ocean Expedition of the U.S. Fisheries Steamer *Albatross*. The holotype (USNM 30046) was collected near Agattu Island in the western Aleutian Islands and is pictured in the original description (Nutting, 1912, plate 11, figs. 1 and 1a). The second specimen was collected off southeastern Honshu Island, Japan, and the deposition of that specimen is unknown. Aside from the holotype, the species is known from only a single specimen collected in southern Kanaga Pass and identified by Dr. F. M. Bayer in 2001 as *Muriceides* cf. *cylindrica* (see photo A on next page). Given the amount of sampling effort in the western Aleutian Islands, this species is either extremely rare or some collected specimens have been misidentified as *M. nigra* (see *M. nigra* Remarks).

Associated fauna include ophiuroids.

Distribution Rare. In Alaska – known only from the holotype collected southeast of Agattu Island in the western Aleutian Islands and one specimen collected in southern Kanaga Pass, central Aleutian Islands (Fig. 9-4). Elsewhere – a single specimen collected by the U.S. Fisheries Steamer *Albatross* near Ose Saki Light, southeast Honshu Island, Japan.

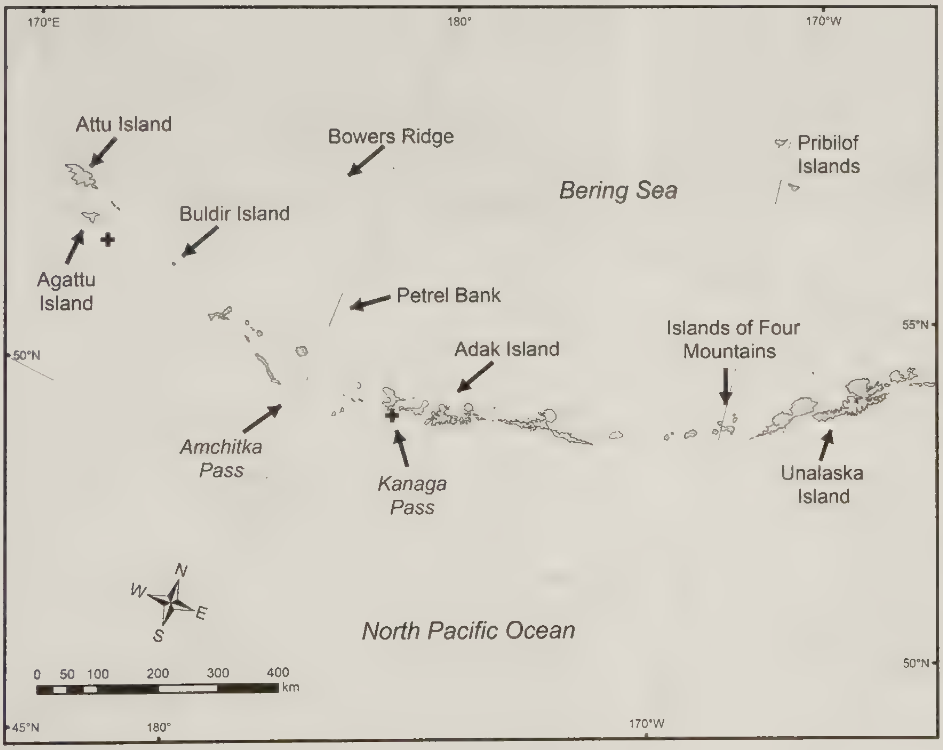
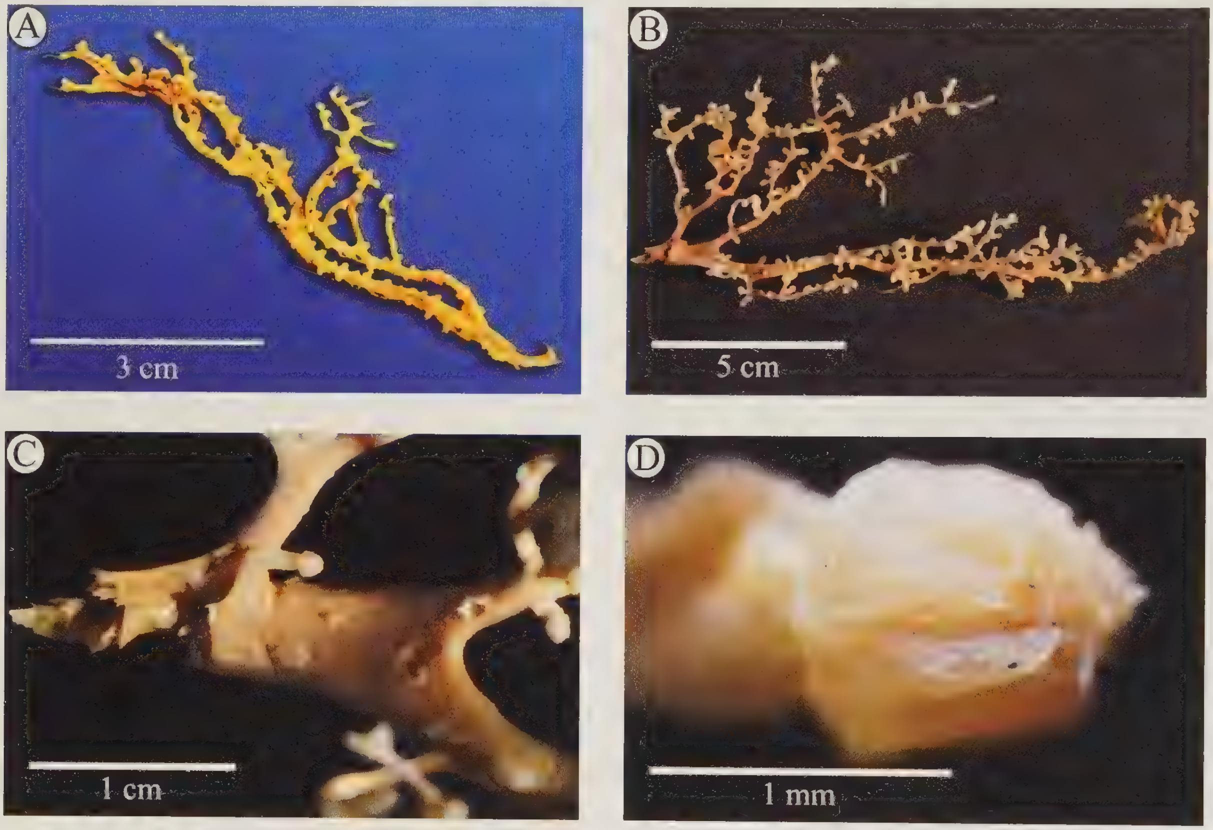


Figure 9-4

A map of the Aleutian Islands showing the distribution of *Muriceides cylindrica* (+) in Alaska waters.

Habitat In Alaska – likely attaches to cobbles and pebbles in areas of moderate current at depths between 393 and 881 m. Elsewhere – depth of 173 m.

Photos A) Branches of a large portion of a dried *M. cylindrica* colony (USNM 1006330) collected south of Kanaga Pass, central Aleutian Islands, at a depth of 393 m. B) A preserved (in ethanol) large portion of a *M. cylindrica* colony (USNM 30046; holotype) collected southeast of Agattu Island in the western Aleutian Islands at a depth of 881 m. C) A close-up view of the same specimen in photo B. D) A close-up view of the same specimen in photo B showing a polyp with prominent spindles.



4. *Muriceides nigra* Nutting, 1912

Description (Adapted from Nutting, 1912) Colonies are flabellate and upright, with robust branches that are somewhat convoluted, turning in all directions, but not anastomosing. Colonies are generally uniplanar but the twisting and turning nature of the branches gives the colony a bushy appearance. The largest known colony is 30 cm in height and 21 cm in width but larger colonies have been observed in situ. The branches are highly variable in width; the proximal main axis is up to 13 mm in diameter and distal branches are up to only 2 mm in diameter (excluding polyps). The axial skeleton is woody, fibrous, quite flexible, and brown under a thick, shiny olive-green sheath, regardless of the color of the coenenchyme. The coenenchyme is thick and is easy to peel away in sheets.

Calyces are distributed all over the main stalk and branches without any obvious order; they may be less abundant on the lower main stalk but are present on the holdfast. Calyces are tubular, generally crowded, and 2–3 mm in diameter. The polyps are only partially retractile, with the crowns resting at the margins.

Sclerites are mostly spindles, quite small for the family, and considerably smaller than those of the congener *M. cylindrica*. The coenenchyme bears small, warty spindles arranged longitudinally. The calyce walls are filled with small spindles that are irregularly arranged and vertically positioned. The operculum is dome-shaped and composed of sclerites arranged *en chevron* on the tentacle bases.

This is one of the most colorful corals found in Alaska. The coenenchyme is predominantly olive green or blue, but may range from brilliant purple to dark-orange crimson and, rarely, golden-light green. The polyps are often a different color than the coenenchyme, with bluish/purple highlights most common, and present a striking visual contrast. In comparison, the coloration in dried and ethanol-preserved specimens could not be more plain and monochromatic. The highlights are faded and many specimens turn a dark brown or even black. The ethanol-preserved holotype was one such specimen, hence the name *nigra* given by Nutting (1912).

Remarks Thoma (2013) performed molecular analysis on 15 *M. nigra* specimens that we collected in the Aleutian Islands and isolated two *mtMutS* haplotypes, representing *M. nigra* (eight specimens) and *Muriceides* sp. (seven specimens). Careful study of these specimens from photographs taken immediately after collection indicated that there are differences regarding the color of the coenenchyme and anthocodiae, the general thickness of the stalk and branches, the density of calyces (polyps), and the depth of collection between specimens, but these parameters were equally represented in either haplotype (senior author, unpubl. data). So for now, we list them all as *M. nigra*, but acknowledge that there is intraspecific variation in some gross morphological parameters and urge that additional molecular work be undertaken.

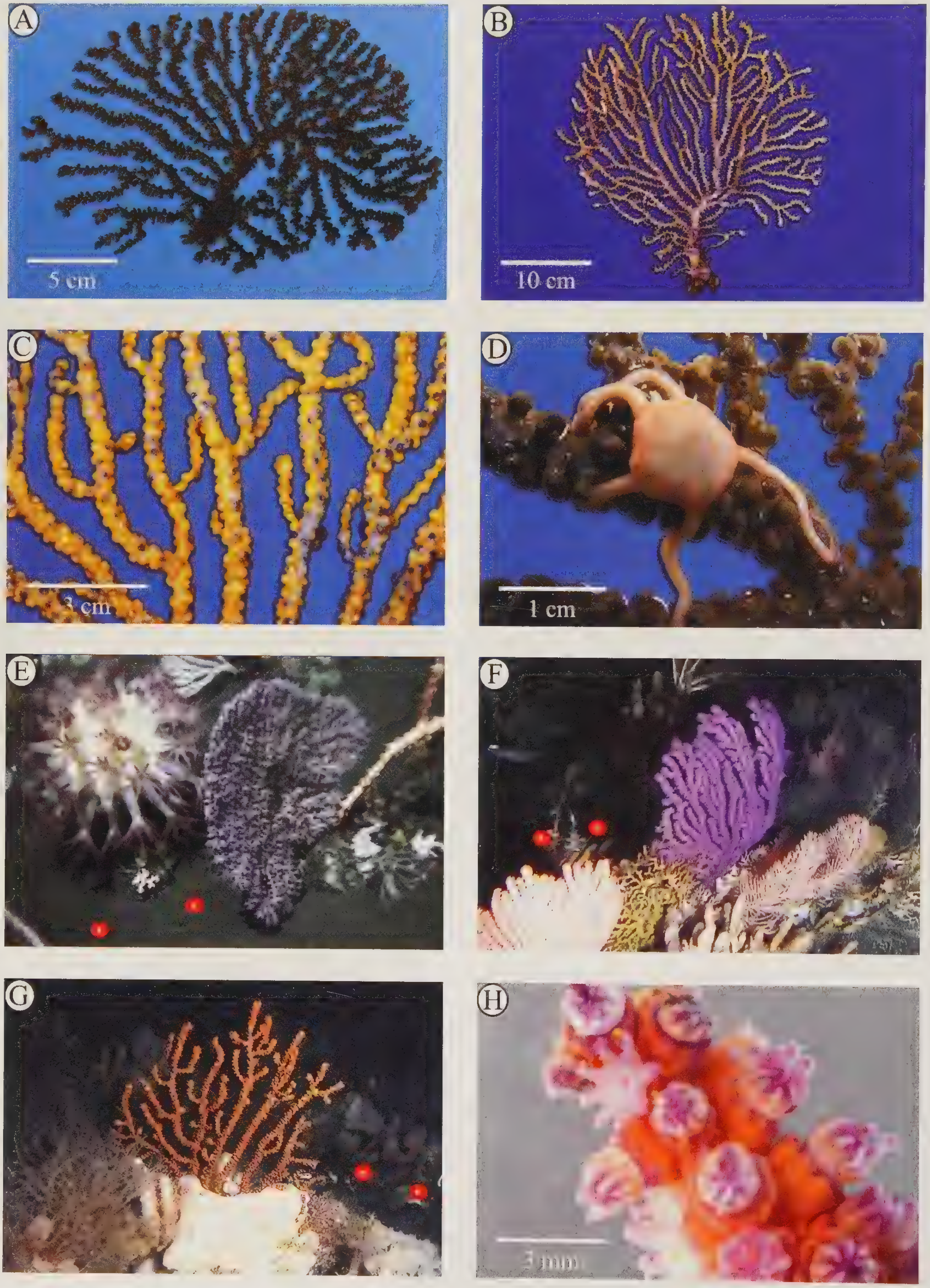
This species hosts an extremely rich suite of associates, including amphipods (families Acanthonotozomellidae, Caprellidae, Ischyroceridae, Pleustidae, and Stenothoidae), isopods (families Janiridae and Munnidae), polychaetes (family Nereididae), ophiuroids that are often cryptically colored and bare sections of the axial skeleton are often substrate for hydroids (including *Bonneviella superba*), small bivalves (family Limidae), and actiniarians (Watling and Stone[7]). The coenenchyme and sclerites are principally composed of high-magnesium calcite (8.6 mol% $MgCO_3$) with minute amounts of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Locally common. In Alaska – Aleutian Islands (south of Unalaska Island to east of Attu Island) including Petrel Bank (Fig. 9-5). Video observations (senior author, personal observ.) indicate that this species ranges to near the northwest end of Bowers Bank. Elsewhere – not reported.

Habitat In Alaska – grows singly or in low-density patches on bedrock, boulders, cobbles, and pebbles at depths between 78 and 824 m, often in association with hexactinellid sponges (in particular those in the family Rossellidae). Video observations in the central Aleutian Islands indicate this species ranges to depths of 1195 m there (Stone, 2014).

Photos A) A fresh whole *M. nigra* colony (USNM 1481899) collected south of Tanaga Island, central Aleutian Islands, at a depth of 489 m. B) A fresh whole *M. nigra* colony (AB02-0116A) collected on Petrel Bank, central Aleutian Islands, at a depth of 87 m. C) A close-up view of a fresh *M. nigra* specimen (USNM 1481891) collected near Kanaga Island, central Aleutian Islands, at a depth of 139 m. D) A close-up view of a fresh *M. nigra* specimen (USNM 1481897) collected south of Tanaga Island, central Aleutian Islands, at a depth of 489 m. E) A *M. nigra* colony (USNM 1481897) collected south of Tanaga Island at a depth of 489 m. F) A *M. nigra* colony (USNM 1481895) collected south of Bobrof Island, central Aleutian Islands, at a depth of 160 m. G) A *M. nigra* colony (USNM 1481896) collected south of Bobrof Island at a depth of 119 m. H) A close-up view of the same specimen in photo G, showing the arrangement and details of the polyp structure. The distance between the red laser marks in photos E–G is 10 cm.

4. *Muriceides nigra* Nutting, 1912 (continued)


A
5 cm
B
10 cm
C
3 cm
D
1 cm
E
F
G
H
3 mm

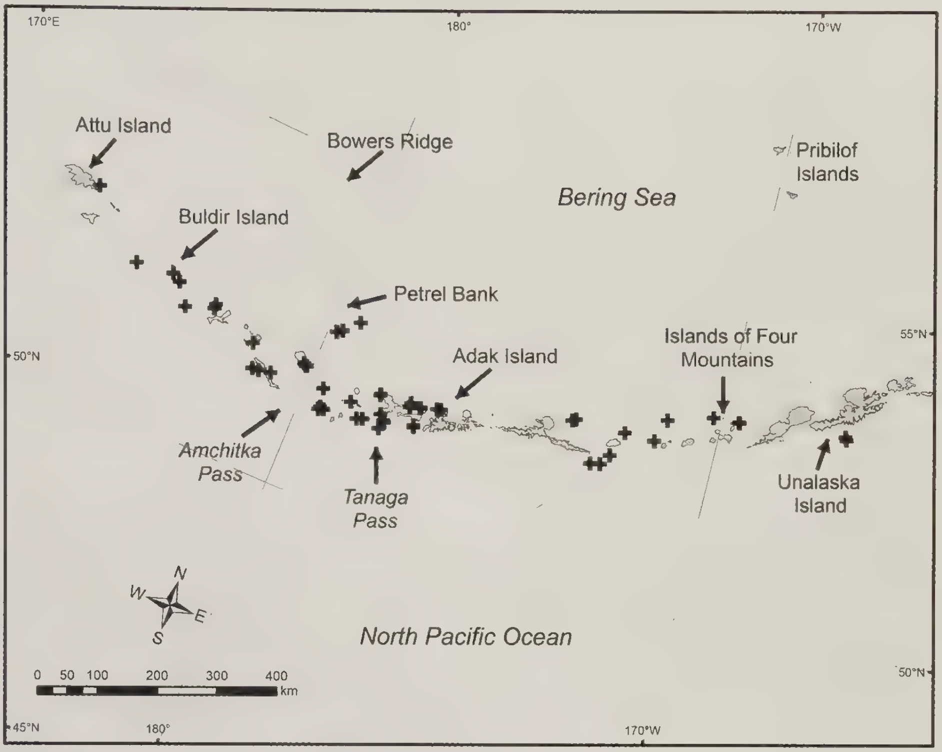

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Adak Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Tanaga Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 9-5

A map of the Aleutian Islands showing the distribution of *Muriceides nigra* (+) in Alaska waters.

CHAPTER 10

Order Scleralcyonacea

The Scleralcyonacea includes the former order Pennatulacea (now superfamily Pennatuloidea) and the order Helioporacea, most taxa in the former suborder Calcaxonia, and a morphologically heterogeneous group of taxa assigned to the former suborders Alcyoniina, Stolonifera, Scleraxonia, and Holaxonia (McFadden et al., 2022). The new order contains taxa with a wide range of growth morphologies, and most taxa have axes of solid calcium carbonate or sclerites fused together with calcitic material.

The World Register of Marine Species currently recognizes 21 families and one superfamily in the order Scleralcyonacea, only six of which are represented in Alaska waters—Chrysogorgiidae, Coralliidae, Keratoisidae, Primnoidae, Sarcodictyonidae, and the superfamily Pennatuloidea.

Family Chrysogorgiidae

(Adapted from McFadden et al., 2022 and Cairns et al., 2021) Chrysogorgiids are octocorals with a solid, non-scleritic skeletal axis that is concentrically layered with calcium carbonate. The axis is smoothly layered, elliptical or circular in cross section, often brittle, and has a metallic luster. Colonies are erect, typically branched (sympodial, dichotomous, bottlebrush, or pinnate), and attached by a heavily calcified holdfast or anchored with a root-like process if inhabiting soft-sediment habitats. Polyps are monomorphic, non-retractile but contractile, and predominantly arranged uniserially along the axis and branches. The sclerite complement includes scales, plates, spindles, and rods.

Of the seven accepted genera of Chrysogorgiidae, only three are found in Alaska waters: *Radicipes* (a single species), and *Chrysogorgia* and *Pseudochrysogorgia* (each represented by three unknown taxa). All three genera were formerly included in the now defunct suborder Calcaxonia. The distribution of the three genera in Alaska is limited to several seamounts in the Gulf of Alaska Seamount Province and the Aleutian Islands (Fig. 10-1). They are a eurybathic fauna but only occupy deep water (1359–4768 m) where they grow directly on hard rock (bedrock, boulders, cobbles, and siltstone) or anchor in soft-sediment habitats.

All chrysogorgiid specimens collected in Alaska waters should be retained and properly preserved for morphological and molecular studies.

Chrysogorgiidae occur worldwide and are a eurybathic (100–4768 m depth) fauna, but in the North Pacific Ocean they only inhabit deep-water habitats where they attach to hard substrate. Colonies are generally small, often wispy, pale to gold-colored, and all-around inconspicuous, so are easily overlooked especially in situ. *Radicipes stonei* Cordeiro et al., 2017 is exceptional in that it often forms dense fields that are notable features in otherwise featureless, deep-water habitats. Here we list seven chrysogorgiid taxa: three tentatively identified simply as *Chrysogorgia*, three tentatively listed as unknown species of *Pseudochrysogorgia*, and the recently described *R. stonei* which had long been known from the region but considered to be the more cosmopolitan *R. pleurocristatus* Stearns, 1883.

Seventy-seven species of *Chrysogorgia* are presently known worldwide (WoRMS Editorial Board, 2022). They are known from all ocean basins and are relatively common in the central North Pacific and central Indo-Pacific regions, but are notably rare in the northern North Pacific Ocean where they are represented by only a few known species: *C. japonica* (Wright and Studer, 1889), known from off Japan at a depth of 1875 m, and *C. pinnata* Cairns, 2007, known from Davidson and Vance Seamounts off California and Oregon (depths 1968–3114 m), and near Hawaii (3957 m). *Pseudochrysogorgia*, on the other hand, was described from a single species collected in the Coral Sea (Pante and France, 2010), but more recently the original authorities and others have identified additional specimens, including several from Alaska, as *Pseudochrysogorgia*.

The main difference between *Chrysogorgia* and *Pseudochrysogorgia* is that the former have sympodial branching and the latter have monopodial branching; that is the principal character that we have used to designate the six unknown Alaska taxa to genus. Specimens have been collected for five of the six taxa and we provide simple macro- and microscopic morphological descriptions here but mitochondrial DNA analyses could facilitate future identification to species. The sixth and most distinctly bottlebrush-shaped taxon, *Pseudochrysogorgia* sp. B, is known only from video observations and we list it here to highlight it as a priority for future collection.

Genus *Chrysogorgia* Duchassaing and Michellotti, 1864

(Adapted from Cairns, 2001) *Chrysogorgia* have branches that spiral around the main stem, or form parallel fans at the top of a short trunk. Branches subdivide dichotomously, either from a regular single, ascending spiral around the main stem or forming two parallel fans above a short main stem. The polyps are few in number, well separated, and large compared to the branches they emanate from. Sclerites consist of spindles, rods, and scales. The axial skeleton has a brilliant metallic luster; some species are quite flexible.

Versluys (1902) established three distinct groups of *Chrysogorgia* species based on the complement and location of sclerites. Group A (Spiculosae) are those species that have rods and/or spindles in the body wall and tentacles. Group B (Squamosae aberrentes) are those species that have rods and/or spindles in tentacles but not in the body wall. Group C (Squamosae typicae) are those species that have only scales; rods and spindles are not present. All three species of *Chrysogorgia* reported here from Alaska belong to Group C.

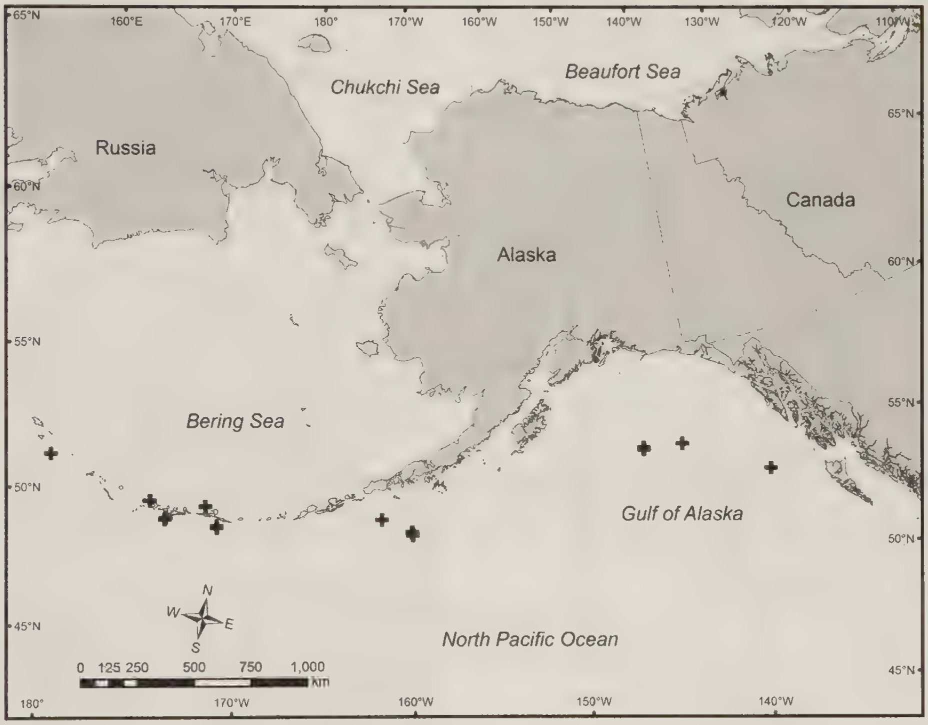

Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 10-1

A map of the North Pacific Ocean showing the distribution of corals in the family Chrysogorgiidae (+) in Alaska waters.

1. *Chrysogorgia* sp. A

Description The branches are sympodial in shape, forming two parallel fans at the top of a short trunk, and arranged in equal dichotomous fashion as is typical for the genus. One fan (photo A, left) was damaged or preyed upon and has no living tissue but rather a light growth of hydroids. The right fan is largely intact but obviously delicate and has dimensions of 10 cm in height and 7.2 cm in width. The coenenchyme is very thin and barely noticeable on the main branches. The thick branches are brown, the thinner branches are olive-green, and the axis presents a metallic luster near the base along the stalk (see photo D).

The polyps are sparse, relatively large (about 1.4 mm in length), and present along the branches and apparently always at the branch tips. Body wall sclerites are smooth platelets 0.20–0.24 mm in length, about 2.5 times as long as wide, and arranged transversely across the body wall in an imbricating arrangement. Tentacular sclerites also appear to be platelets, slightly smaller in length than the body wall sclerites, and also imbricating. Coenenchymal sclerites are also platelets. All platelets are slightly constricted medially.

This species has a prominent (1.8 cm maximum in diameter), discoidal calcareous holdfast that is creamy white in color. The color of the thin coenenchyme and polyps is very pale orange.

Remarks The tentacular and coenenchymal sclerite complement place this taxon in Group C *sensu* Versluys, 1902.

Distribution Uncommon. In Alaska – known from two specimens collected in the Aleutian Islands; one in Adak Canyon and the other southeast of Agattu Island (Fig. 10-2). Examination of video footage at the Adak Canyon collection site indicated that there were multiple patches of three to five colonies in the immediate vicinity. Elsewhere – unknown.

Habitat In Alaska – found on siltstone ridges in linear rows and in small patches with the primnoids *Plumarella profunda* Cairns, 2011 and *Parastenella doederleini* (Wright and Studer, 1889) at depths between 1913 and 2514 m.

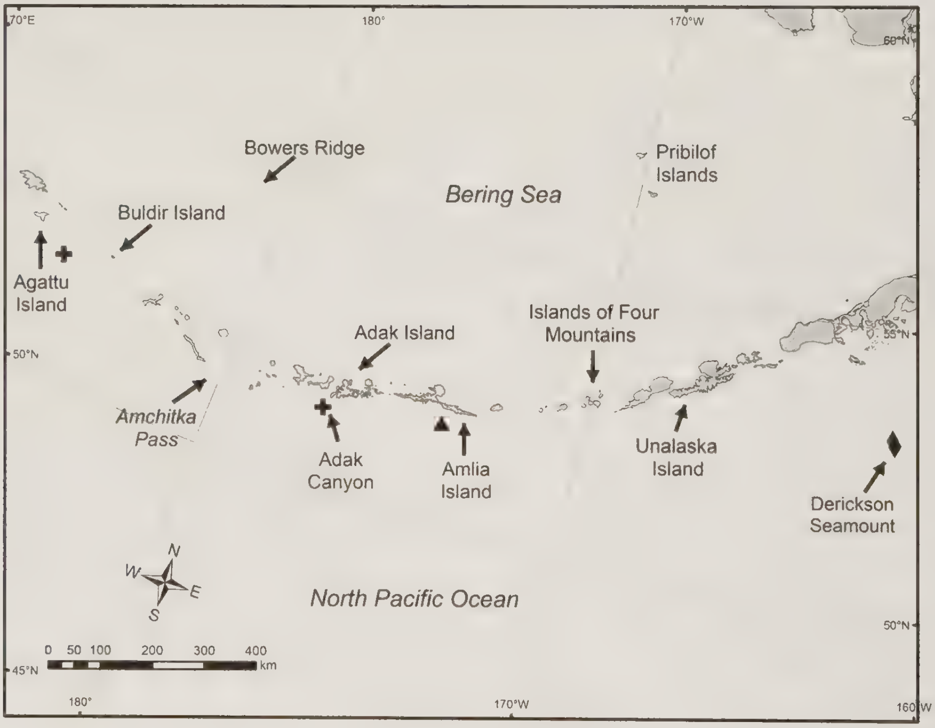
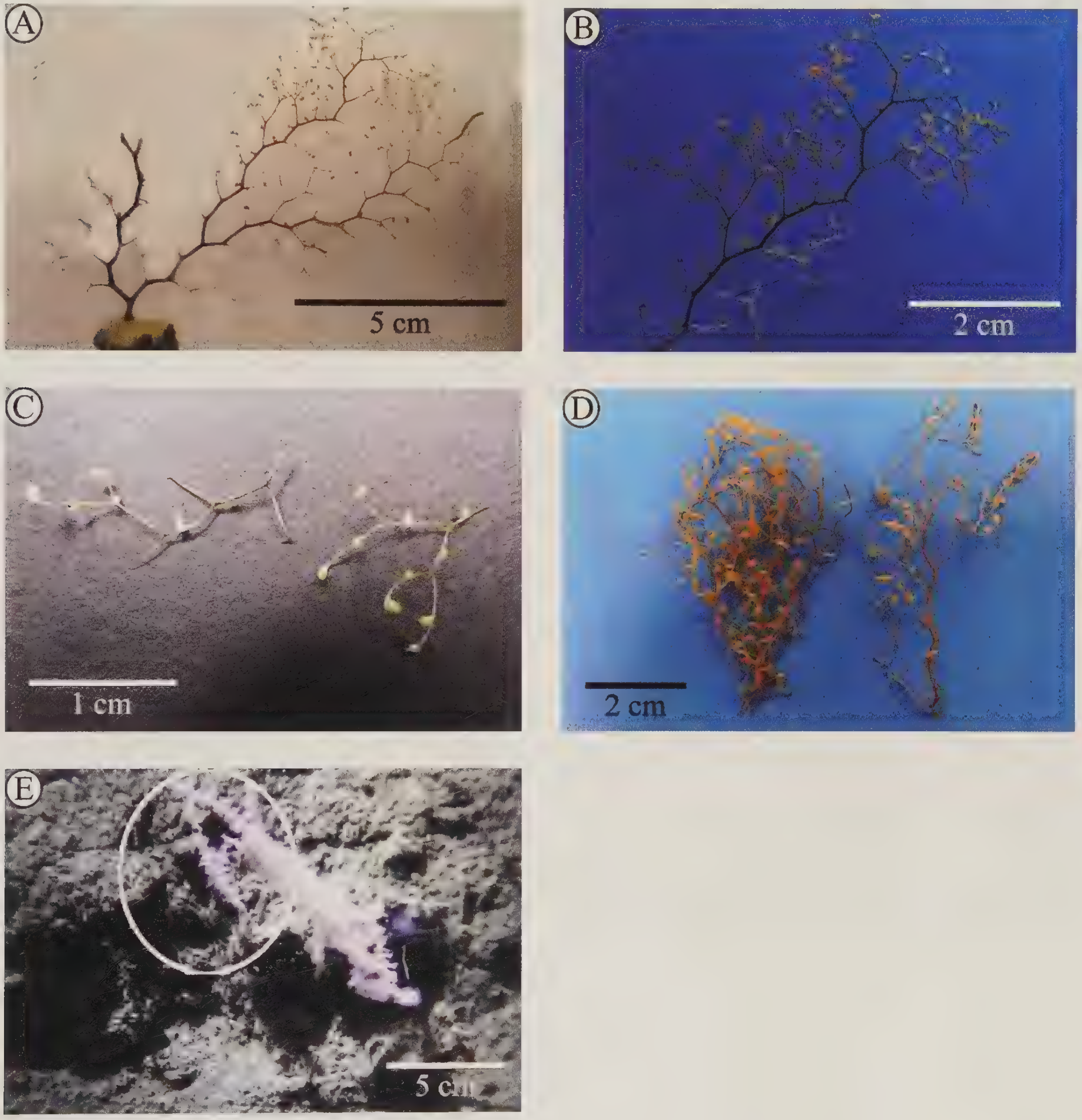

170°E
180°
170°W
60°N
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
+
Agattu Island
50°N
Islands of Four Mountains
Adak Island
55°N
Amchitka Pass
+
Adak Canyon
▲
Amlia Island
Unalaska Island
◆
Derickson Seamount
N
W
E
S
North Pacific Ocean
50°N
0 50 100 200 300 400 km
45°N
180°
170°W
160°W

Figure 10-2

A map of the Aleutian Islands showing the distribution of *Chrysogorgia* sp. A (+), *Chrysogorgia* sp. B (◆), and *Chrysogorgia* sp. C (▲) in Alaska waters.

Photos A) A large portion of a fresh *Chrysogorgia* sp. A colony (USNM 1679741) collected in Adak Canyon, central Aleutian Islands, at a depth of 2514 m. B) A close-up view of the most distal branch of the same specimen in photo A. C) A close-up view of the polyps of the same specimen in photo A. D) Large portions of two preserved (in ethanol) *Chrysogorgia* sp. A colonies (USNM 30152) collected southeast of Agattu Island, central Aleutian Islands, at a depth of 1913 m. E) A small *Chrysogorgia* sp. A colony (indicated by the white circle) at the Adak Canyon collection site at 2514 m. A *Plumarella profunda* colony is at right.



2. *Chrysogorgia* sp. B

Description The species is known from five collected specimens and multiple video observations made in the immediate vicinity of the collections. The branches are sympodial in shape, with a relatively short (approximately 6 mm) but stout unbranched stem (compared to *Chrysogorgia* sp. A), and then branched in a single plane but with multiple small fans that are often in slightly offset planes and giving the appearance of being slightly bushy. The largest colony has dimensions of 31 cm in height and 32 cm in width. Polyps are relatively large and abundant compared to the other two *Chrysogorgia* species listed here and are located along all sides of the branches including termini. Polyps are unifacial (i.e., pointed towards one of the faces), stout, and measure about the same in height and diameter (2.5 mm). Body wall sclerites are thin, smooth, elongate, irregularly shaped platelets up to 0.35–0.45 mm in length. Tentacular and coenenchymal sclerites are the same but smaller (approximately 0.20 mm in length).

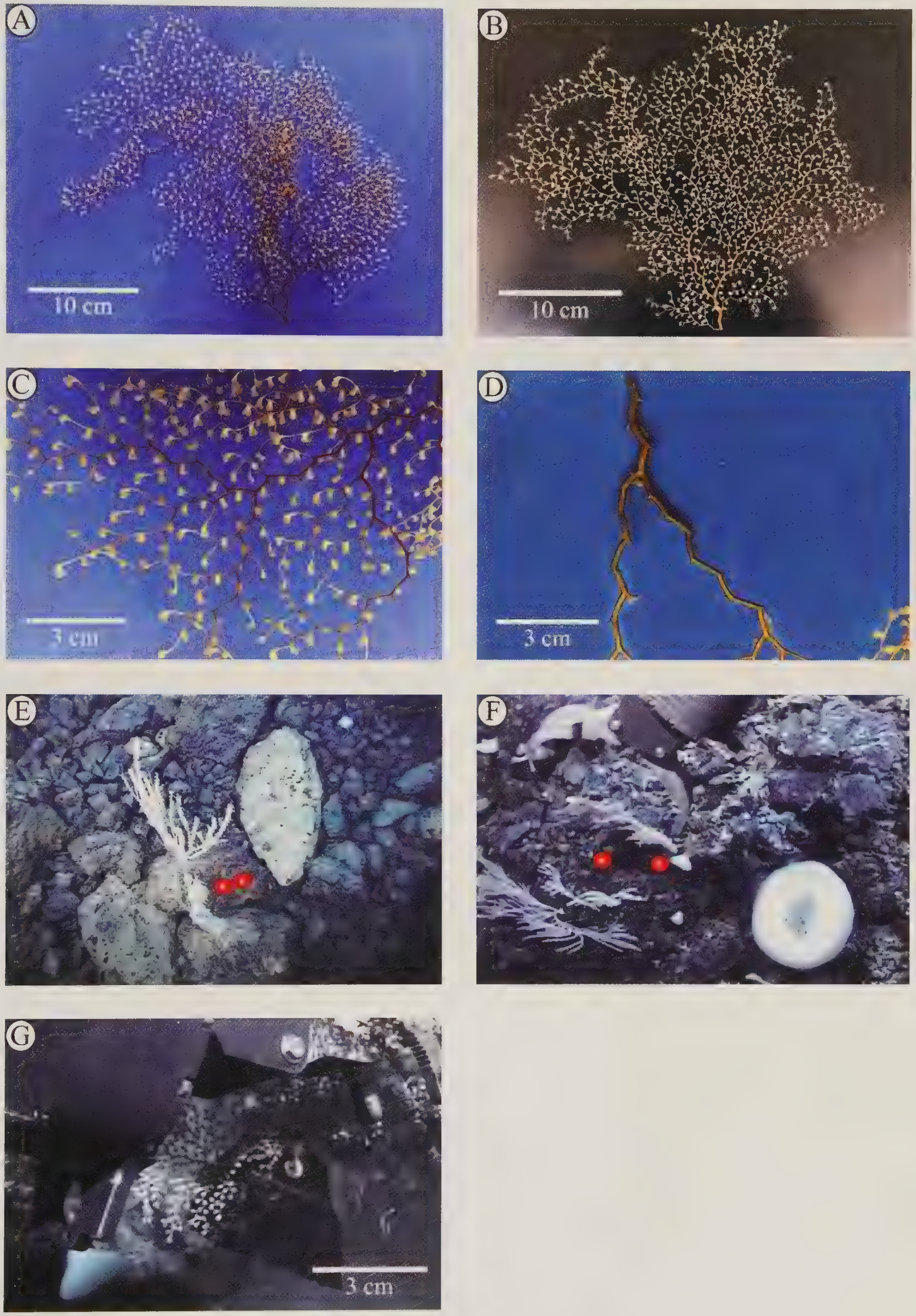
This species has a small (approximately 6 mm in diameter), circular but flat, calcareous holdfast that is strongly attached to the substrate and white in color. The color of the axis, visible beneath the very thin coenenchyme, is golden with a brilliant metallic sheen. The color of the coenenchyme is light pink to white in life and light orange in ethanol.

Remarks The tentacular and coenenchymal sclerite complement place this taxon in Group C *sensu* Versluys, 1902. This species co-occurs with *Pseudochrysogorgia* sp. C but differs in being more robust with far more polyps and often having a slightly bushy appearance.

Distribution Uncommon. In Alaska – known only from Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 10-2). Elsewhere – unknown.

Habitat In Alaska – found singly and in small patches on boulder, fractured bedrock, and occasionally on vertical bedrock at depths between 3358 and 4768 m.

Photos A) A mostly whole preserved (in ethanol) *Chrysogorgia* sp. B colony (USNM 1081178) collected on Derickson Seamount at a depth of 4162 m. B) A mostly whole preserved (in ethanol) *Chrysogorgia* sp. B colony (USNM 1081181) collected on Derickson Seamount at a depth of 4329 m. C) A close-up view of the branching pattern and polyps of the same specimen in photo A. D) A close-up view of the stalk and main branches of a preserved (in ethanol) *Chrysogorgia* sp. B specimen (USNM 1081176) collected on Derickson Seamount at a depth of 3991 m. E) A *Chrysogorgia* sp. B colony (USNM 1081176; left of the red laser marks) prior to collection on Derickson Seamount at a depth of 3991 m. F) A *Chrysogorgia* sp. B colony (USNM 1081175; above the red laser marks) prior to collection on Derickson Seamount at a depth of 3358 m. G) A close-up view of the polyps (contracted) and holdfast of the same colony in photo F. The distance between the red laser marks in photos E and F is 10 cm.


A
10 cm
B
10 cm
C
3 cm
D
3 cm
E
F
G
3 cm

3. *Chrysogorgia* sp. C

Description Branches are arranged in a sympodial fashion in one plane, slightly spiraling and bottlebrush-shaped but not like a typical *Chrysogorgia*. The largest colony is 14.7 cm in height and about 12 cm in width. Colonies are delicate, wispy, and flimsy with dichotomous branching alternately from the main axis. Branching begins close to the inconspicuous holdfast. The largest branches subdivide in multiple planes. All of the polyps appear to be on the top side of the branches and leaning distad. Polyps are elongate; the neck can be slightly narrower than the head, up to 2.3 mm in length and about one-third that in diameter. Body wall, coenenchymal, and tentacular sclerites are elongate platelets (0.20 mm in length and about four times longer than width), arranged longitudinally and not imbricate.

The holdfast is very small and delicate. The stem and branches are golden-green; stem and thicker branches are slightly metallic. The coenenchyme is relatively thick, pinkish-white and slightly reflective in situ, but light orange when brought to the surface.

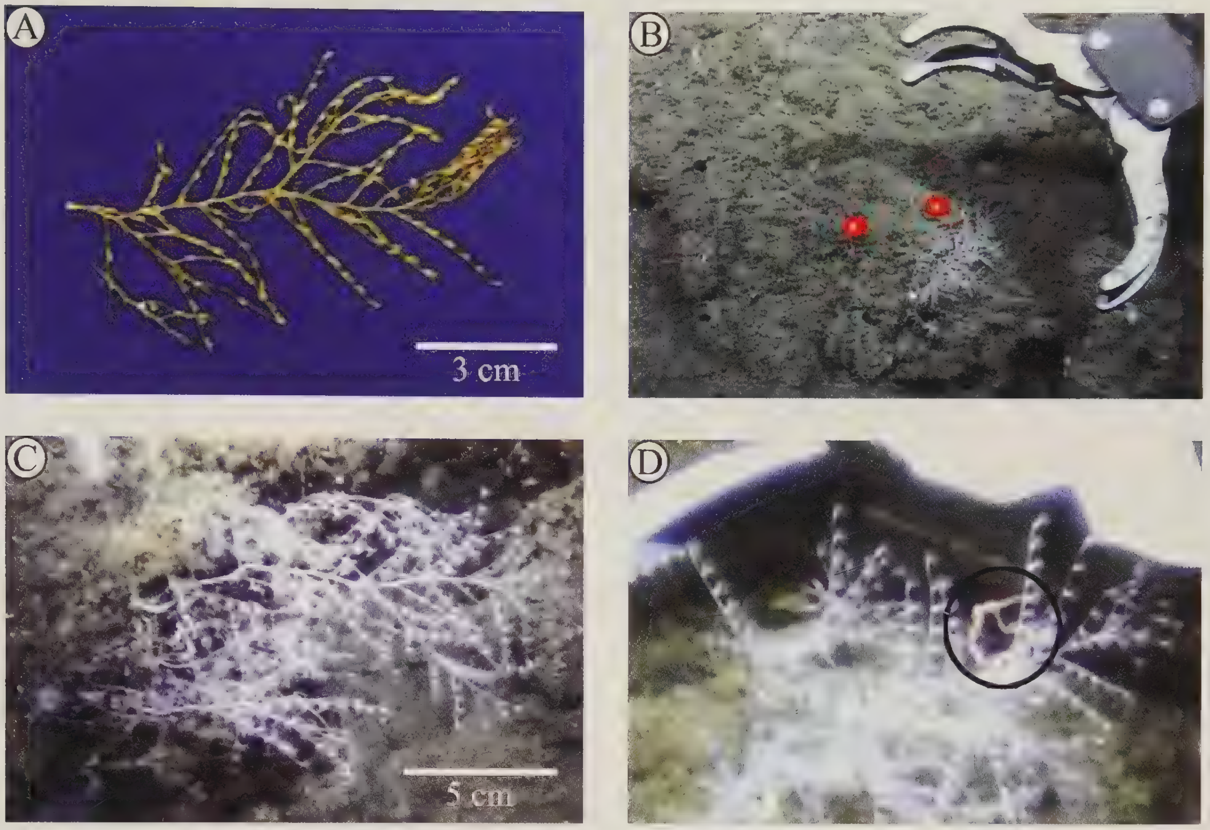
Remarks Here we list an unknown species that conforms more to the description of *Chrysogorgia* than *Pseudochrysogorgia* but not completely to either. We cannot determine completely how the specimens compare to *Pseudochrysogorgia* since the description for the genus (Pante et al., 2012) provided no information on the arrangement of sclerites in the body wall. It may be an unknown genus represented by four specimens collected at two sites; one was collected by the U.S. Fisheries Steamer *Albatross* in 1906 and identified by Nutting as *Chrysogorgia* sp. and the second lot of three specimens (collected by us in 2004) was also identified as *Chrysogorgia* sp. (Pante et al., 2012).

Associated fauna include large caprellid amphipods (*Caprella* sp.; see photo C).

Distribution Rare. In Alaska – known only from near Amlia Island in the Aleutian Islands (Fig. 10-2). Elsewhere – unknown.

Habitat In Alaska – found in small patches on siltstone exposures in areas of low current and at depths near 1359 m.

Photos A) A fresh whole *Chrysogorgia* sp. C colony (USNM 1659740) collected southwest of Amlia Island in the central Aleutian Islands at a depth of 1359 m. B) A cluster of three *Chrysogorgia* sp. C colonies, including the colony in photo A (center), just before collection. The distance between the red laser marks is 10 cm. C) A close-up view of the same cluster of the three colonies in photo B. D) A caprellid amphipod (black circle) perched on the same colonies in photo B.


A
3 cm
B
C
5 cm
D

Genus *Pseudochrysogorgia* Pante and France, 2010

(Adapted from Pante and France, 2010) *Pseudochrysogorgia* are monopodial colonies that are often bottlebrush-shaped and slightly zigzagging. They have abundant, dichotomously subdivided branches in multiple planes that originate in an irregular or regular spiral around a relatively tall, upright main stem. The distance between branches along the stem is short (<2 cm) and regular. Most polyps are oriented slightly distad, enlarged somewhat distally at the head, and most often equally wide and tall. Polyps have slightly ornamented sclerites of irregular shape, in the form of plates, scales, and rods. The branch coenenchyme contains sclerites in the form of scales and plates that are mostly parallel to the main branch axis. The axis and larger branches are typically a dull black but characterized by a dark metallic luster.

The three species of *Pseudochrysogorgia* as we list them here appear to be strictly limited to Dickens, Pratt, Quinn, and Derickson Seamounts in the Gulf of Alaska Seamount Province at depths between 1854 and 4712 m.

4. *Pseudochrysogorgia* sp. A

Description Colonies are monopodial, not spiraling or bottlebrush-shaped, with alternate pinnate, uniplanar branching. Colonies are up to 19 cm in height and 10.5 cm in width, delicate but rigid and easily broken. Branching does not begin close to the small holdfast, which is partially calcified. The largest branches subdivide in multiple planes, sometimes at perfect right angles. Polyps occur on both sides of the main axis in no particular pattern, including on the stem below the first branching. The coenenchyme is relatively thin, and pinkish-white and slightly reflective in situ but light orange to white when brought to the surface or in ethanol. The unbranched stem of some colonies may have an olive-green hue when alive.

Polyps stand perpendicular to the stem, are spaced 4 mm apart, point upward, and have very long, pointed tentacles. Polyps are slender (twice as high as wide), cylindrical, and up to 3 mm in length. The base of the expanded polyp contains eggs and is covered with transversely oriented rods. Body wall sclerites are rods covered with low granules, 0.35–0.40 mm in length, arranged longitudinally on the body. Tentacular sclerites are the same but smaller, about 0.25 mm in length, with two or three sclerites across a tentacle at the base.

Remarks *Pseudochrysorgia* is currently monotypic, represented only by *Pseudochrysogorgia bellona* Pante and France, 2010 from the Coral Sea. Here we list an unknown species represented by one collected specimen and several video observations; given the vast distance between collection sites it is unlikely *P. bellona.*

Distribution Uncommon. In Alaska – known only from Pratt and Quinn Seamounts in the Gulf of Alaska Seamount Province (Fig. 10-3). Elsewhere – unknown, but there is one other *Pseudochrysorgia* specimen (USNM 1112696) collected from the North Pacific Ocean (Brooks Bank near Midway Island at 835 m depth).

Habitat In Alaska – occurs singly on bedrock, fractured bedrock including basalt, and boulders at depths between 1854 and 2227 m.

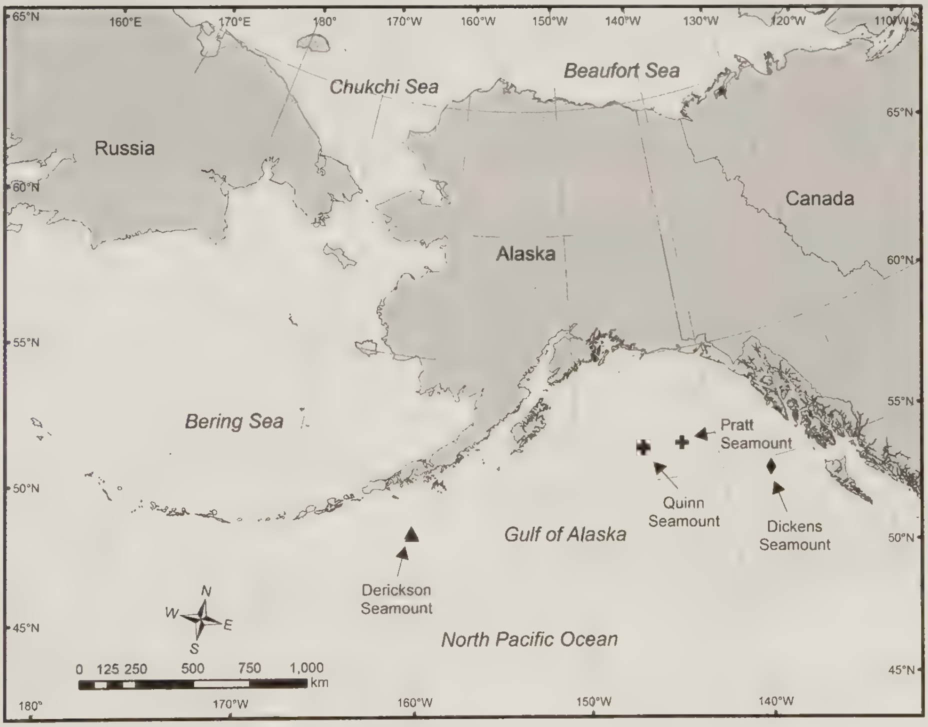
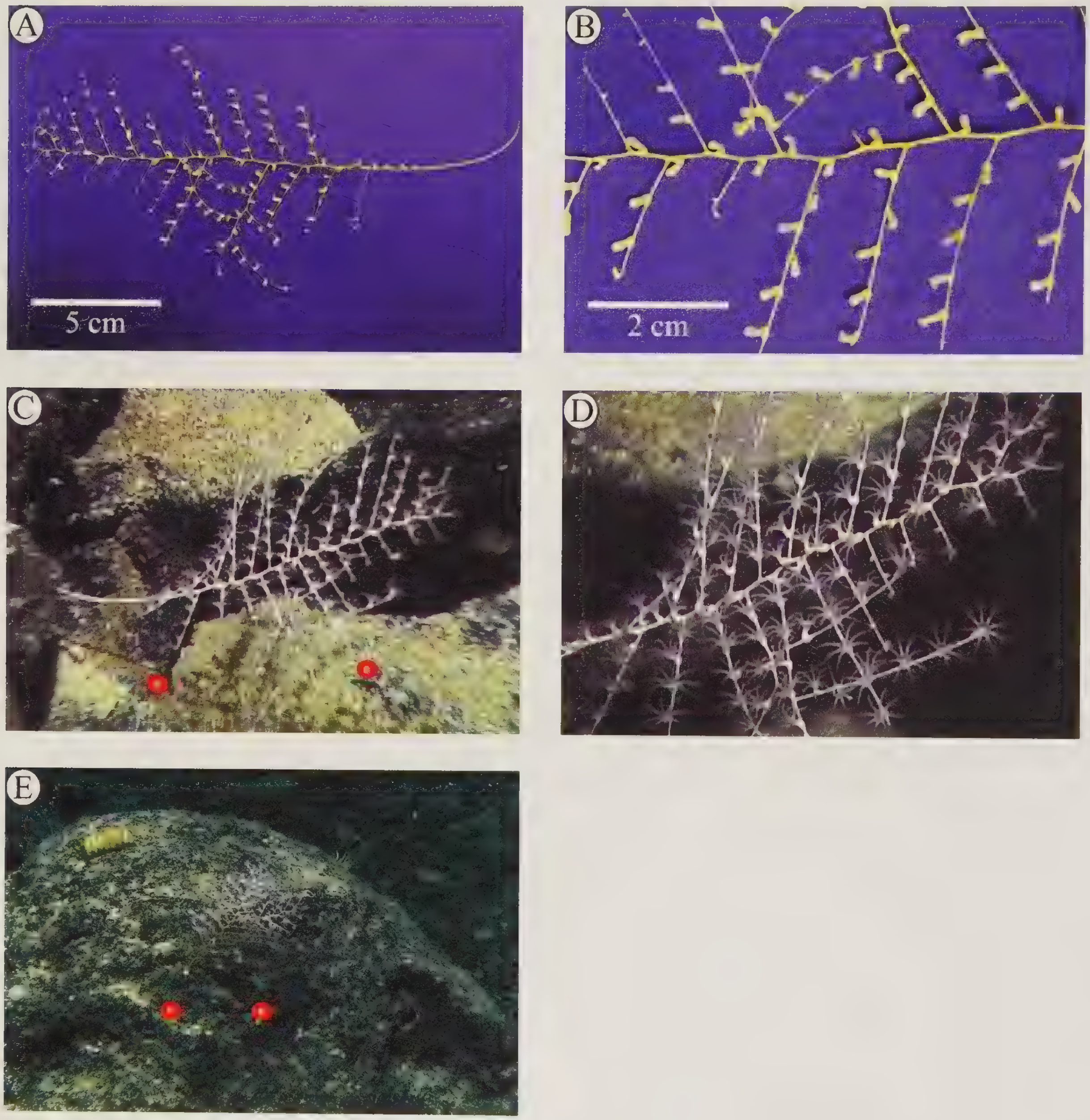

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
60°N
55°N
50°N
45°N
Bering Sea
Pratt Seamount
Quinn Seamount
Dickens Seamount
Gulf of Alaska
Derickson Seamount
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
180°
170°W
160°W
150°W
140°W

Figure 10-3

A map of the North Pacific Ocean showing the distribution of *Pseudochrysogorgia* sp. A (+), *Pseudochrysogorgia* sp. B (♦), and *Pseudochrysogorgia* sp. C (▲) in Alaska waters.

Photos A) A preserved (in ethanol) whole *Pseudochrysogorgia* sp. A colony (USNM 1075801) collected on Pratt Seamount at a depth of 1854 m. B) A close-up view of the same specimen in photo A. C) The same colony in photo A prior to collection. D) The same colony in photo A in situ showing the branching pattern and large polyps. E) A *Pseudochrysogorgia* sp. A colony photographed on Quinn Seamount at a depth of 2136 m. The distance between the red laser marks in photos C and E is 10 cm.



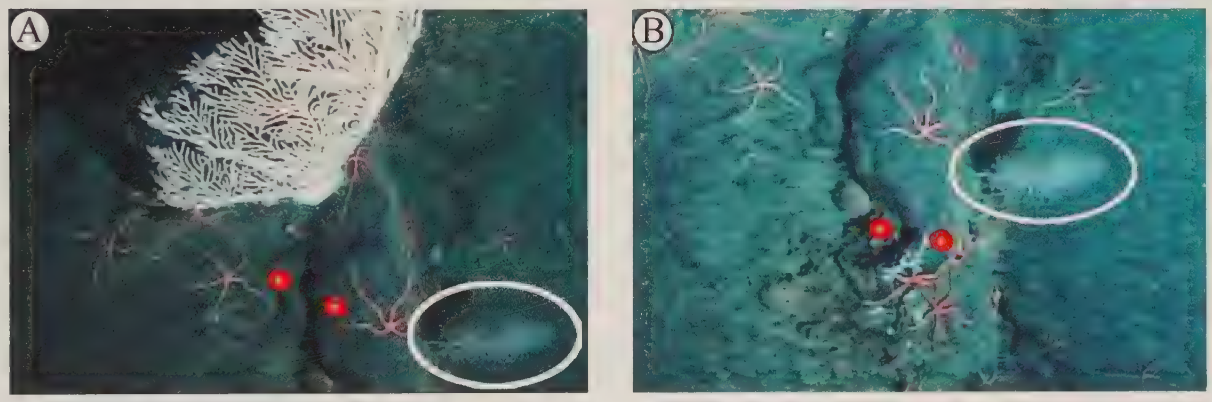
5. *Pseudochrysogorgia* sp. B

Description This taxon is known from only a single colony photographed on Dickens Seamount in the eastern Gulf of Alaska. We list it here as a separate taxon to highlight it for future collection. It is the only chrysogorgiid known from Alaska that is classically bottlebrush-shaped, and it appears to be monopodial with elaborate branching around a stout main stem that is unbranched for the lower 4–5 cm. The approximate dimensions of the colony are 19 cm in length and 8 cm in diameter. Polyps appear to be abundant and large. The color of the colony in situ appears to be white with a slight metallic hue.

Distribution Rare. In Alaska – known only from Dickens Seamount in the Gulf of Alaska Seamount Province (Fig. 10-3). Elsewhere – unknown.

Habitat Grows on bedrock at a depth of 2787 m with the primnoid *Calyptrophora laevispinosa* Cairns, 2007.

Photos A) A *Pseudochrysogorgia* sp. B colony (indicated by the white ellipse) photographed on Dickens Seamount at a depth of 2787 m. The colony is growing on the same bedrock outcrop as a large *C. laevispinosa* colony. B) An alternate view of the same colony in photo A (indicated by the white ellipse). The distance between the red laser marks in photos A and B is 10 cm.



6. *Pseudochrysogorgia* sp. C

Description This species is known from only two collected specimens and multiple video observations. Colonies are monopodial, with relatively long unbranched stems (compared to the other species) and then branching to multiple small, planar fans. The largest colony has dimensions 23 cm in height and 22 cm in width. Polyps are relatively large (up to 4.7 mm in length) but sparse (spaced 11–12 mm apart) and located along the top and termini of branches. Polyps consist of a narrow cylindrical upper portion and a bulbous lower portion up to 2 mm in diameter that contains eggs. Body wall sclerites are slender rods, 0.42–0.50 mm in length, and longitudinally arranged. Tentacular sclerites are also rods but smaller (0.35 mm in length); the base of the polyp (covering the egg mass) contains irregularly shaped platelets 0.25 mm in length.

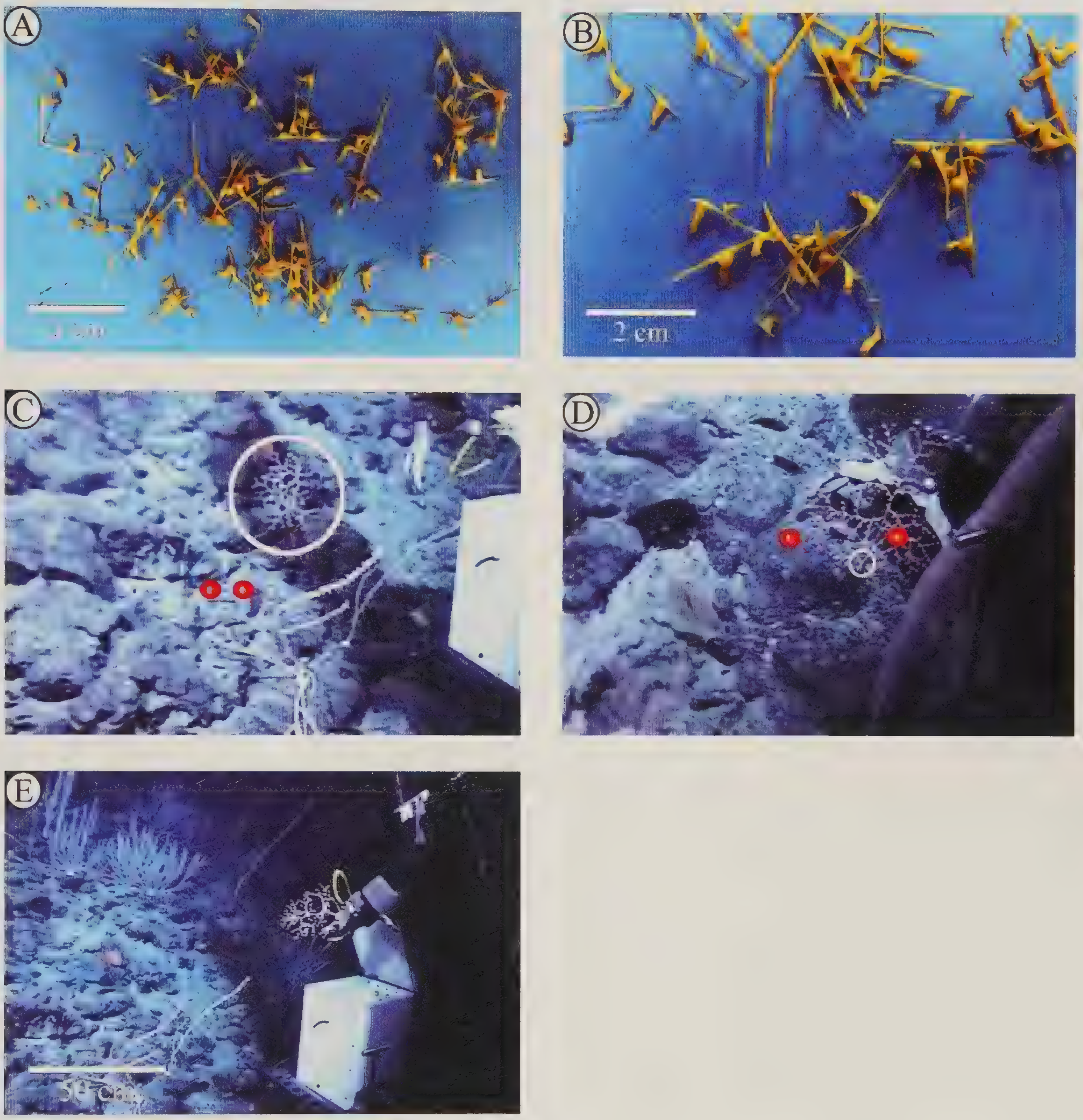
Colonies have a small, inconspicuous calcareous holdfast that is strongly attached to the substrate. The axis and branches are light olive-green with a slight metallic sheen. The color of the coenenchyme in life is light pink to white and in ethanol-preserved specimens it is light orange-yellow.

Remarks This species co-occurs with *Chrysogorgia* sp. B but differs in being much more delicate with far fewer polyps and never having a slightly bushy appearance. This species also occurs with the keratoisidids *Bathygorgia profunda* and *Isidella* sp. B.

Distribution Uncommon. In Alaska – known only from Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 10-3). Elsewhere – unknown.

Habitat In Alaska – found singly on bedrock including steep vertical walls, fractured bedrock, and boulders at depths between 4103 and 4712 m.

Photos A) Preserved (in ethanol) branch fragments of a *Pseudochrysogorgia* sp. C colony (USNM 1081180) collected on Derickson Seamount at a depth of 4168 m. B) A close-up view of the same specimen in photo A. C) A *Pseudochrysogorgia* sp. C colony (USNM 1081177; indicated by the white circle) collected on Derickson Seamount at a depth of 4162 m. D) A close-up view of the same specimen in photo C. The holdfast is indicated by the white circle. The distance between the red laser marks in photos C and D is 10 cm. E) The same colony in photo C during collection. Note that the colony was growing in a mixed field with *B. profunda* and *Isidella* sp. B.


A
1 cm
B
2 cm
C
D
E
50 cm

7. *Radicipes stonei* Cordeiro et al., 2017

Description (Adapted from Cordeiro et al., 2017) Colonies are delicate, unbranched, flagelliform, and spirally twisted or coiled in either direction but more commonly counterclockwise. The largest colonies are up to at least 150 cm in length; axis diameter is up to 2.9 mm; and the axis tapers slightly to the tip. The axis is stiff enough to maintain colonies off the seafloor and is thus an excellent indicator of water current direction and strength. Smaller colonies (<70 cm) have polyps near the base but the lower part (up to 12 cm) of larger colonies is sterile (devoid of polyps). The coenenchyme is somewhat thin; the dark axis is visible distally. Colonies arise from a somewhat flexible, calcified holdfast that is modified with root-like processes for attaching to pebbles lodged in the sediment (see photo C).

Polyps (1.0–3.0 mm in length) are inclined 45–90° in relation to the axis and arranged uniserially along one side of the axis, producing obvious polypar and abpolypar sides of the colony. Polyps are closely packed, ranging to 5 polyps/cm, but are less closely packed distally. The sclerites are rods and scales located in the polyp walls, coenenchyme, tentacles, and pinnules and are described in detail in the original description of the species.

Colonies are light orange, light pink, or cream-colored in situ; light orange on deck; and light olive-green in ethanol with the characteristic iridescence of other chrysogorgiids.

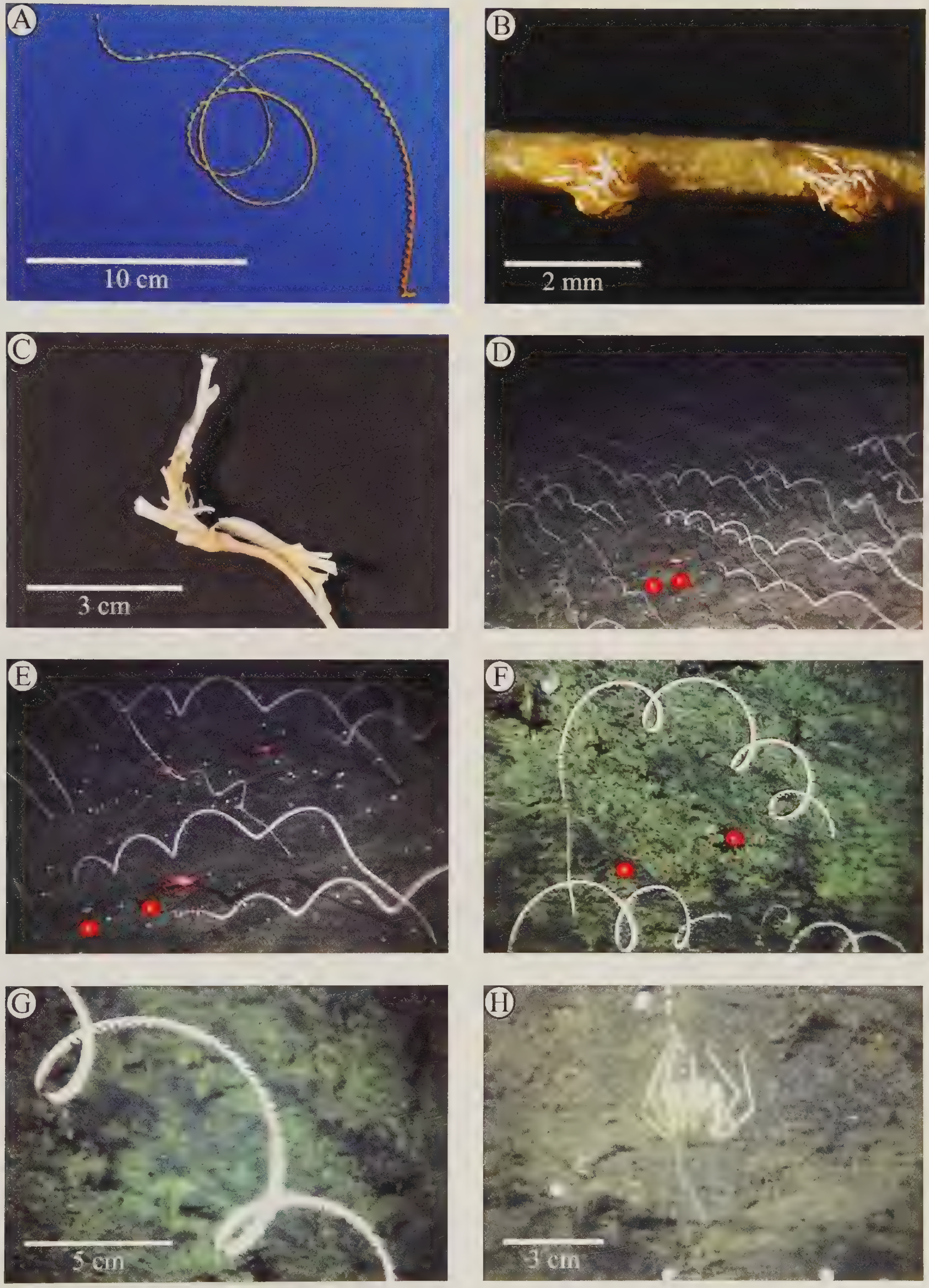
Remarks This species is most similar to *Radicipes pleurocristatus*, known from the eastern North Pacific (Japan to Indonesia) and from shallower depths (629–1301 m). The body wall sclerites for both species are long, rounded rods but are smaller (<0.8 mm) in *R. stonei* than in *R. pleurocristatus* (≥2.0 mm). The coenchymal sclerites of the latter species are also more strongly sculpted and have what we call a "woody" appearance.

Larger colonies are occasionally used by the sea spider (Pycnogonida, *Colossendeis* sp.) as a resting perch (see photo H). Interestingly, although the large ophiuroid *Asteronyx* sp. is common at depths where *R. stonei* was present, none were observed using the colonies as elevated perches, whereas they were common on the co-occurring pennatuloidean *Anthoptilum* sp. A. The congener *R. pleurocristatus* often serves as a perch for *Asteronyx loveni* in Japanese and Indonesian waters (Fujita and Ohta, 1988).

Distribution Locally abundant. In Alaska – Aleutian Islands (south of Unimak Pass to northwest of Tanaga Island) and on Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 10-4). Elsewhere – recently collected west of Cordell Bank in northern California. This highly disjunct distribution suggests that the species could range along the west coast of North America in deeper areas not yet explored.

Habitat In Alaska – found on siltstone exposures and attaches to pebbles in low-relief sand/silt habitats at depths between 1612 m (Stone, 2014) and 3580 m (Cordeiro et al., 2017). Elsewhere – depths between 2072 and 2646 m.

Photos A) The fresh whole *R. stonei* holotype (USNM 1418007) collected northwest of Tanaga Island, central Aleutian Islands, at a depth of 2107 m. B) A close-up view of the polyps on a preserved (in ethanol) *R. stonei* specimen (USNM 1418006) collected north of Atka Island in the central Aleutian Islands at a depth of 2153 m. C) A close-up view of the root-like holdfast of the same specimen in photo B. D) A field of *R. stonei* colonies in Adak Canyon, central Aleutian Islands, at a depth of 2479 m. E) A zoomed-in view of the same field of colonies in photo D. F) A *R. stonei* colony (J2095-2-1-1) collected southwest of Amlia Island, central Aleutian Islands, at a depth of 2827 m. G) A close-up view of the same colony in photo F. H) The tip of a *R. stonei* colony (USNM 1418006) with an associated pycnogonid (*Colossendeis* sp.). The distance between the red laser marks in photos D–F is 10 cm.


A
10 cm
B
2 mm
C
3 cm
D
E
F
G
5 cm
H
3 cm

7. *Radicipes stonei* Cordeiro et al., 2017 (continued)

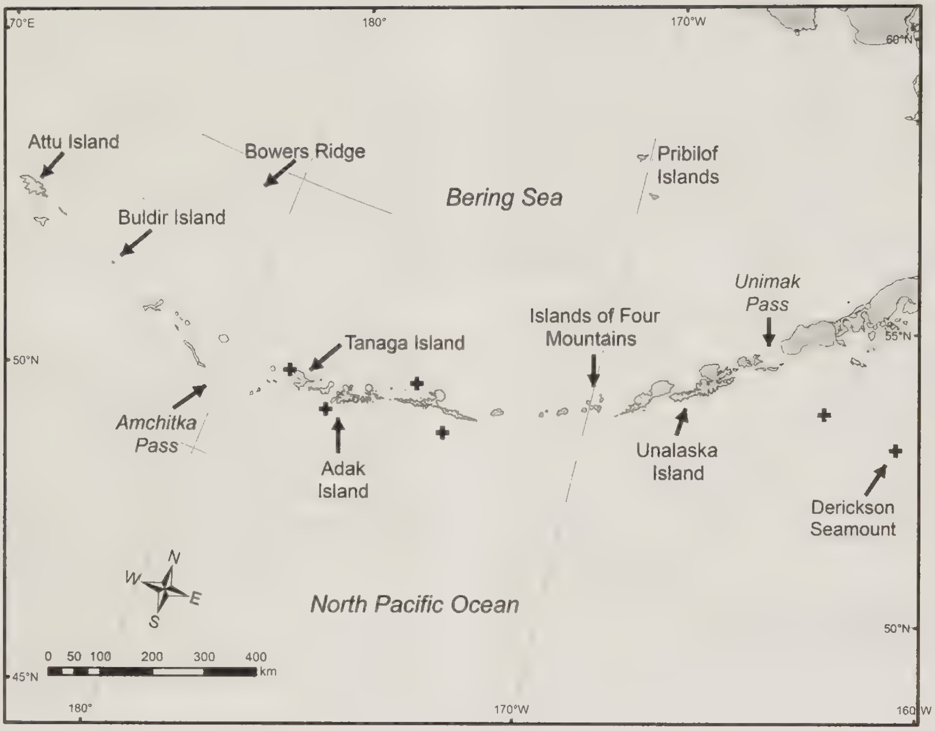

170°E
180°
170°W
60°N
Attu Island
Bowers Ridge
Bering Sea
Pribilof Islands
Buldir Island
Unimak Pass
Islands of Four Mountains
Tanaga Island
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
Derickson Seamount
N
W
E
S
North Pacific Ocean
50°N
0 50 100 200 300 400
km
45°N
180°
170°W
160°W

Figure 10-4

A map of the Aleutian Islands showing the distribution of *Radicipes stonei* (+) in Alaska waters.

CHAPTER 11

Family Coralliidae

(Adapted from McFadden et al., 2022) Coralliids are octocorals with or without a skeletal axis of fused or unfused sclerites. Colonies with axes are usually erect, planar, and variably branched. Colonies without axes are typically hemispherical to digitiform, capitate with a conspicuous sterile stalk, or on occasion sparsely branched or lobate. Polyps are dimorphic with feeding autozooids and reproductive siphonozooids and are retractile directly into the coenenchyme or cortex surrounding the axis. Polyps may lack sclerites or have a mixed complement of spindles, ovals, rods, or radiates. Coenenchyme sclerites are radiates and spheroids without tubercles and occasionally with blunt rods and spindles. Sclerites are often brightly colored shades of red.

The family Coralliidae contains 14 genera with four of them designated in the subfamily Anthomastinae, including the familiar Alaska genera *Heteropolypus* (three taxa) and *Pseudoanthomastus* (one species). Other genera found in Alaska waters include *Hemicorallium* (one species), *Paragorgia* (six taxa), and *Sibogagorgia* (one species). The former two genera were previously included in the now defunct suborder Alcyoniina and the later three were formerly included in the now defunct suborder Scleraxonia. Coralliidae are found in all regions of Alaska except the Arctic and some genera are locally abundant (Fig. 11-1). They are a eurybathic fauna mostly found in deep water (21–2766 m) where they grow directly on hard rock (bedrock, fractured bedrock, boulders, cobbles, and large pebbles), siltstone, hexactinellid sponge skeleton, and shell. All *Hemicorallium*, *Sibogagorgia*, and *Pseudoanthomastus* specimens collected in Alaska waters should be retained and properly preserved for morphological and molecular studies.

The taxonomy and systematics of octocorals in the former family Paragorgiidae from the North Pacific Ocean are best described as uncertain and in a state of

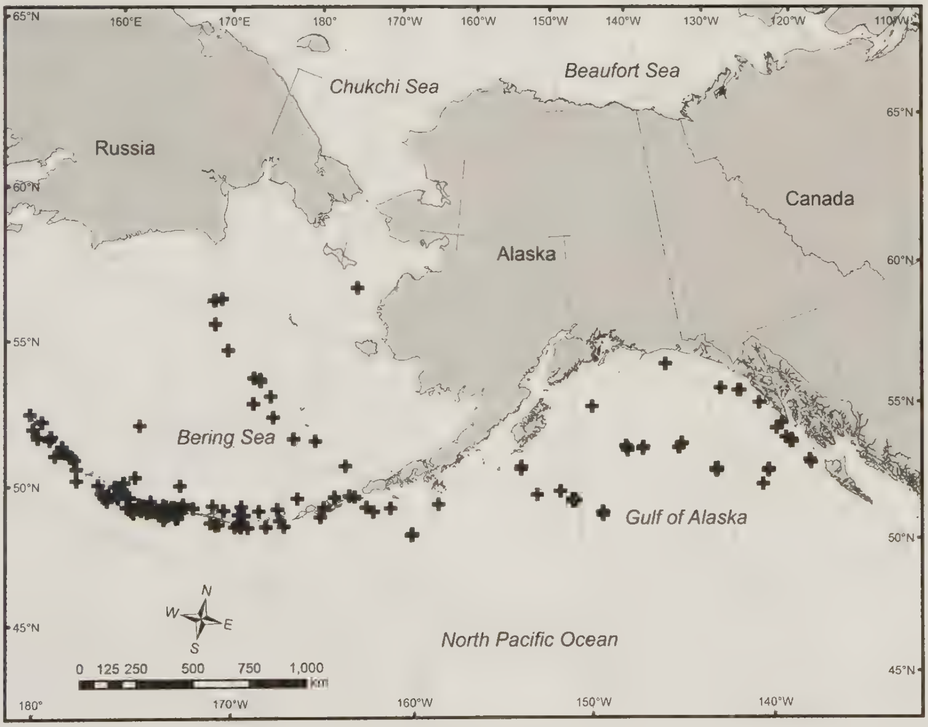


Figure 11-1

A map of the North Pacific Ocean showing the distribution of corals in the family Coralliidae (**+**) in Alaska waters.

flux. Phenotypically they are incredibly diverse. For example, Alaska bubblegum corals, previously designated as *Paragorgia arborea* (Linnaeus, 1758) until recently and now *Paragorgia arborea* var. *pacifica* Verrill, 1922, are by far the most diverse in Alaska in terms of gross colony morphology (e.g., size range, branching pattern, surface features, and color), zoogeography, and depth range. However, for the family Paragorgiidae, the microscopic characteristics traditionally used to differentiate species (sclerites) are subtle, and molecular DNA techniques have proven to be somewhat unreliable and conflicting (Herrera and Shank, 2016). Future work using new methodologies, such as restriction site-associated DNA sequencing in combination with careful study of gross morphological characteristics and ecology, should help elucidate the systematics of the genera *Paragorgia* and *Sibogagorgia*.

Here we have adopted the most recent systematics for the former family Paragorgiidae and list four accepted species: *Paragorgia jamesi* Herrera and Shank, 2016; *Paragorgia arborea* var. *pacifica* and morph *nodosa*; *Paragorgia stephencairnsi* Sánchez, 2005; and *Sibogagorgia cauliflora* Herrera et al., 2010. We additionally list two suspected undescribed species (*Paragorgia* sp. A and *Paragorgia* sp. B) to highlight them for future taxonomic work. *Paragorgia arborea* var. *pacifica* is one of the most abundant, widespread, and ecologically important corals in Alaska waters, so we highlight that species by designating two morphs: *arborea* and *nodosa*. Historically, these two morphs were considered separate species, thus we present them in that way to retain information regarding differences in morphology, biogeography, and ecology.

1. *Hemicorallium* sp.

Description This taxon is known in Alaska from only two collected specimens and a third specimen (mostly a skeleton) observed very close to one of the collected specimens (see photo D). The largest of the two specimens (USNM 1082614) is uniplanar and 20 cm in height and 38 cm in width. The following detailed description is based on the smaller specimen (USNM 1075800). The collected corallum (a large branch complex) is uniplanar and quite fragile, 23 cm in height and 13 cm in width; the broken basal stem is 8×9 mm in diameter. The whole colony was measured with lasers in situ at 30 cm in height and 42 cm in width. The branching is irregularly dichotomous; the short distal branchlets are rarely more than 10 mm in length. Branch anastomosis does not occur. The axis is smooth; both the axis and the coenosteum are pale pink. The distal branchlets bear squat, cylindrical (about 1.2 mm in height and 1.4 mm in diameter in the contracted state), longitudinally grooved calices, 9–11 on each branchlet occurring in random order but not on the posterior side. Small papillae (siphonozooids) cover the coenosteum on all sides of the branches. Elongate, slender rods measuring up to 0.12 mm in length occur, presumably from the calyx; however, the predominant sclerite type is eight-radiates, which are 0.08–0.10 mm in length. The color of the corallum is a uniform light pink; the polyps are very light pink to clear.

Remarks These specimens are placed in the recently resurrected genus *Hemicorallium* (see Ardila et al., 2012) because they have slender calicular rods, cylindrical autozooids, and a smooth axis. The closest geographical congeners are *H. regale* (Bayer, 1956) and *H. laauense* (Bayer, 1956), both from the Hawaiian region. Based on Bayer's (1956) key to the genus, these specimens are most similar to *H. laauense*, but detailed study of additional specimens is needed to make a definitive identification. Herrera and Shank (2016) used molecular genetics techniques (restriction site-associated DNA sequencing analysis) to assign specimen USNM 1075800 to *H. imperiale-laauense* (an unaccepted combination); however, if identification to either species (*H. imperiale* or *H. laauense*) is correct, it would constitute a huge geographical range extension (about 2800 km) from the known distribution in the Hawaiian region.

This species is very similar in gross morphology (e.g., branching pattern) and color to *Paragorgia* sp. B and the two species could easily be mistaken for each other in situ. Fortunately, they only co-occur on Patton Seamount but have separate, non-overlapping depth ranges there.

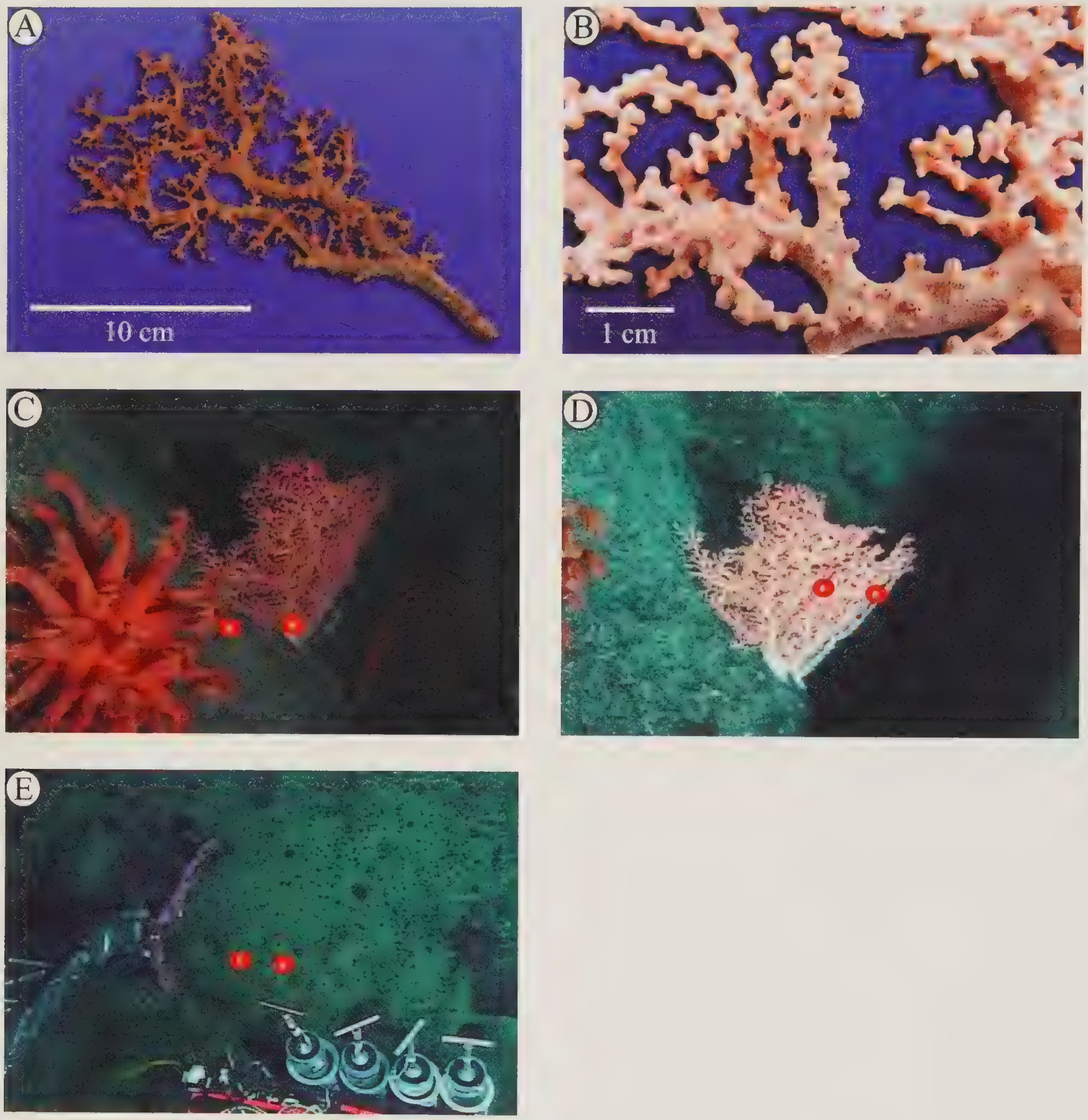
Corals in the genera *Hemicorallium* and *Corallium* are also known as precious corals and are commercially harvested in parts of the world for the jewelry trade. Coral fisheries are managed by local jurisdictions in some regions and some are regulated under the authority of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2007; Appendix III); consequently, they are one of the most well-studied groups of corals worldwide. All coralliids are azooxanthellate species and most have life-history characteristics that make them particularly vulnerable to over-exploitation (i.e., *K*-selected species), including extreme longevity (75–200 years), late age of maturity (7–12 years), slow growth (2–20 mm in length and 0.24–1.32 mm in diameter per year, with growth rates declining with age), low fecundity, and low natural mortality rates (Grigg, 2002; Baco and Shank, 2005; Bramanti et al., 2005; Roark et. al., 2006). *Hemicorallium* specimens, possibly *H. regale*, from Davidson Seamount off central California showed a linear growth rate of approximately 2.5 mm/year, indicating a colony age of about 115 years; however, based on the radial growth rate, an age of up to 200 years is possible (Andrews et al., 2005).

Distribution Rare. In Alaska – Pratt and Patton Seamounts in the Gulf of Alaska Seamount Province (Fig. 11-2). Elsewhere – unknown.

Habitat In Alaska – occurs singly or in small patches on bedrock and fractured bedrock (boulder) at depths between 1677 and 1779 m. Elsewhere – *Hemicorallium regale* is found on hard rock at depths between 300 and 1815 m and *H. laauense* is found on hard rock at depths between 366 and 1807 m.

Photos A) A dried branch from a *Hemicorallium* sp. colony (USNM 1075800) collected on Pratt Seamount at a depth of 1677 m. B) A close-up view of the same specimen in photo A. C) The same colony in photos A and B photographed in situ. D) Alternate view of the same colony in photo C. A second colony consisting of mostly a skeleton attached to the substrate is visible to the right of the live colony. E) A *Hemicorallium* sp. colony (USNM 1082614) photographed during collection on Patton Seamount at a depth of 1779 m. The distance between the red laser marks in photos C–E is 10 cm.

1. *Hemicorallium* sp. (continued)


A
10 cm
B
1 cm
C
D
E

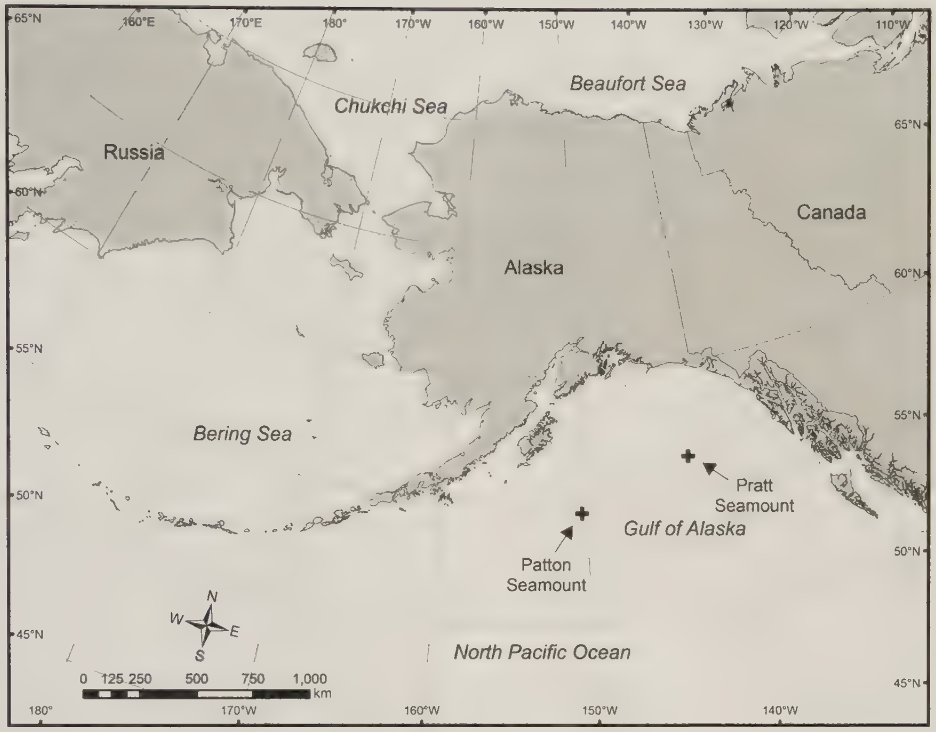

Beaufort Sea
Chukchi Sea
Russia
Canada
Alaska
Bering Sea
Pratt Seamount
Gulf of Alaska
Patton Seamount
North Pacific Ocean
0 125 250 500 750 1,000 km

Figure 11-2

A map of the North Pacific Ocean showing the distribution of *Hemicorallium* sp. (+) in Alaska waters.

2. *Paragorgia jamesi* Herrera and Shank, 2016

Background Specimens examined by Sánchez (2005) to describe *Paragorgia stephencairnsi* were re-examined using restriction site-associated DNA sequencing analysis and the species complex differentiated into a shallow and a deep-water sub-clade (Herrera and Shank, 2016). Based on the specimens examined (all from British Columbia except two from southern California), those authors somewhat arbitrarily designated the deep (1168–1194 m) specimens as *P. jamesi* and the shallow (32–350 m) specimens as *P. stephencairnsi*. They additionally listed five specimens from Alaska (Herrera and Shank, 2016, suppl. table 1) ranging in depth from 171 to 751 m as *P. stephencairnsi*. Otherwise they noted that the morphology of the two species was nearly identical based on the original description (see page 182 for *P. stephencairnsi*) except that the lobulated rays of the seven- and eight-radiate surface sclerites in *P. jamesi* have mostly rounded edges, whereas those from *P. stephencairnsi* have mostly sharp edges.

Neither the original description for *P. stephencairnsi* (Sánchez, 2005), the revised morphological diagnosis for *P. stephencairnsi* (Herrera and Shank, 2016), nor the new description for *P. jamesi* (Herrera and Shank, 2016) provided much detail on colony morphology, including branching pattern and color. Our microscopic examination of one of the Alaska specimens (USNM 1484230) confirmed that it conformed to the sclerite morphology described for the species complex but also indicated that the characteristic (geometry of the rays of the surface sclerites) used to differentiate the two species was too unreliable to be used to designate the specimens to species. Additionally, we found no clear demarcation regarding bathymetric distribution (171–944 m) for the Alaska specimens. However, close examination of museum specimens and archived in situ video footage revealed the presence of two distinct forms with regard to external morphological characteristics. Based on that examination, we separated the complex into the two species previously described (*P. jamesi* and *P. stephencairnsi*).

Description *Paragorgia jamesi* displays two morphological forms (morphs) in Alaska: a yellow morph (photos A, B, E, and F) that occurs on the continental slope and seamounts, and a pink morph (photos C, D, G, and H) that appears to be restricted to seamounts in the Gulf of Alaska Seamount Province (Pratt, Quinn, and Giacomini). Both morphs overlap spatially on the seamounts where they co-occur.

The yellow morph is the dominant one; it often has a candelabrum shape, is mostly planar, and is variably branched including occasional whiplike colonies. The largest colonies are about 55 cm in height and 30 cm in width with up to 50 branch tips. This morph is not as robust as the pink form. All branch tips are clavate and some of the outer branches and tips appear to be flattened. Two colonies often grow together with a common holdfast (see photos A and E). Holdfasts are small but strongly attached; the branches are fragile and easily broken. The colony is generally a light yellow color; the autozooid apertures are red to crimson-red, numerous, not raised, and often aligned in rows; and the polyps are light orange.

The pink morph is more robust but typically has fewer branches and is often scraggly in appearance, occasionally planar. The largest colonies are about 75 cm in height and 60 cm in width; some colonies have up to 45 branch tips. All branch tips are clavate and some of the outer branches and tips appear to be flattened. This morph has fewer autozooids that are more randomly situated on the branches, slightly raised, and with darker pink autozooid apertures. The coenenchyme is light pink and the polyps are light red. Holdfasts are small but strongly attached; the branches are fragile and easily broken.

Remarks Seamount colonies host hippolytid shrimps, the sternostylid crab *Sternostylus iaspus*, and ophiuroids including *Asteronyx* species.

Distribution Uncommon but locally abundant. In Alaska – specimens have been collected in the eastern GOA and the region where the western GOA meets the eastern Aleutian Islands. Specimens and many video records have been collected from Dickens, Welker, Pratt, Quinn, Murray, Giacomini, and Patton Seamounts in the Gulf of Alaska Seamount Province (Fig. 11-3). This species is particularly abundant on Dickens Seamount. Elsewhere – known only from the type specimens collected in northern (holotype; RBCM 010-00234-004; 2344) and southern (paratype; USNM 1007316) British Columbia.

This species appears to be spatially discrete from *P. stephencairnsi* but does overlap spatially with *P. arborea* var. *pacifica*, *Paragorgia* sp. A, and *Paragorgia* sp. B on seamounts in the Gulf of Alaska Seamount Province.

Habitat In Alaska – occurs in patches, rarely singly, in rough habitat with moderate current. Attaches to bedrock, fragmented bedrock, boulder, cobble, large pebbles, and siltstone at depths between 372 and 944

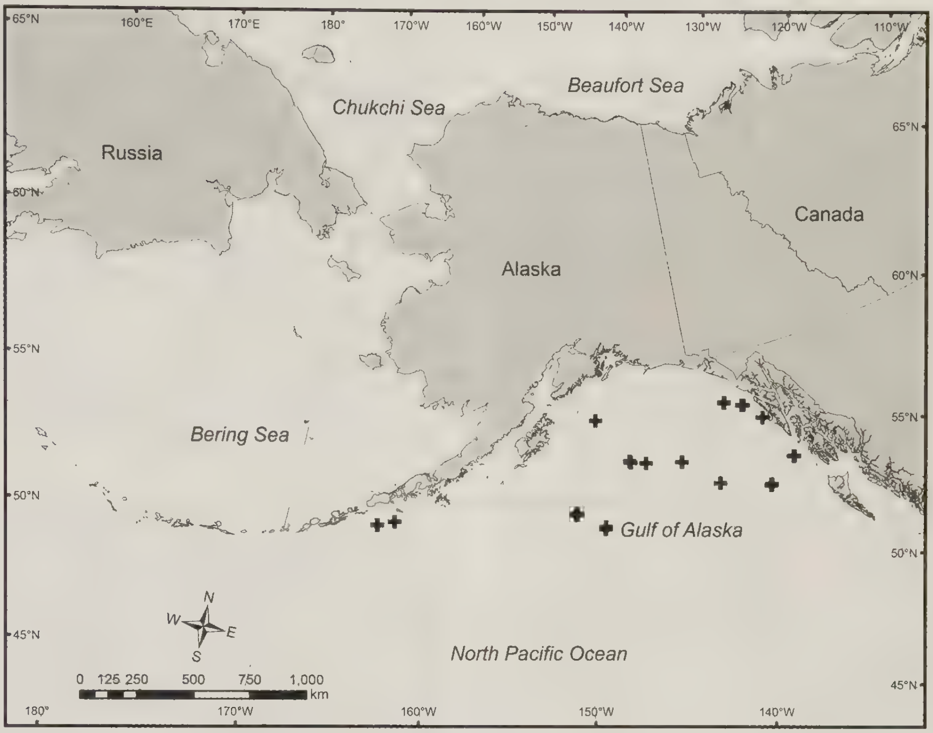
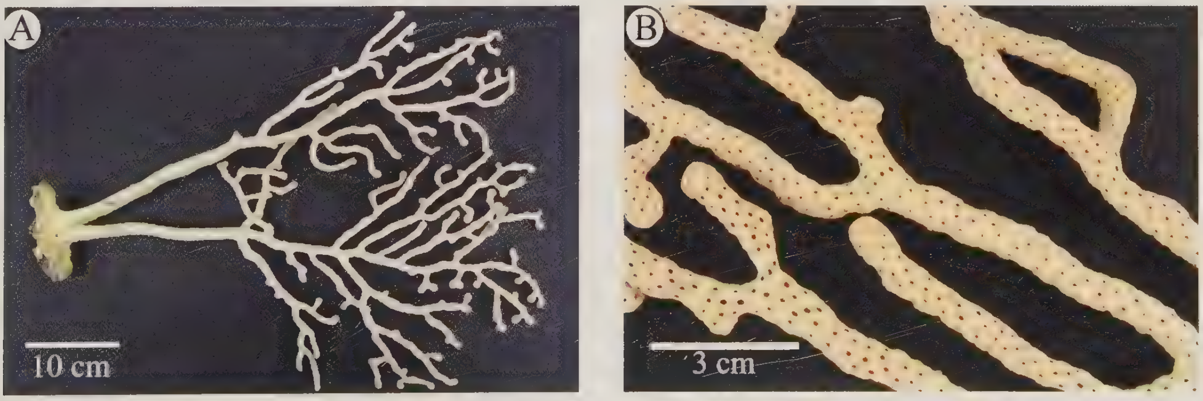

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
60°N
65°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 11-3

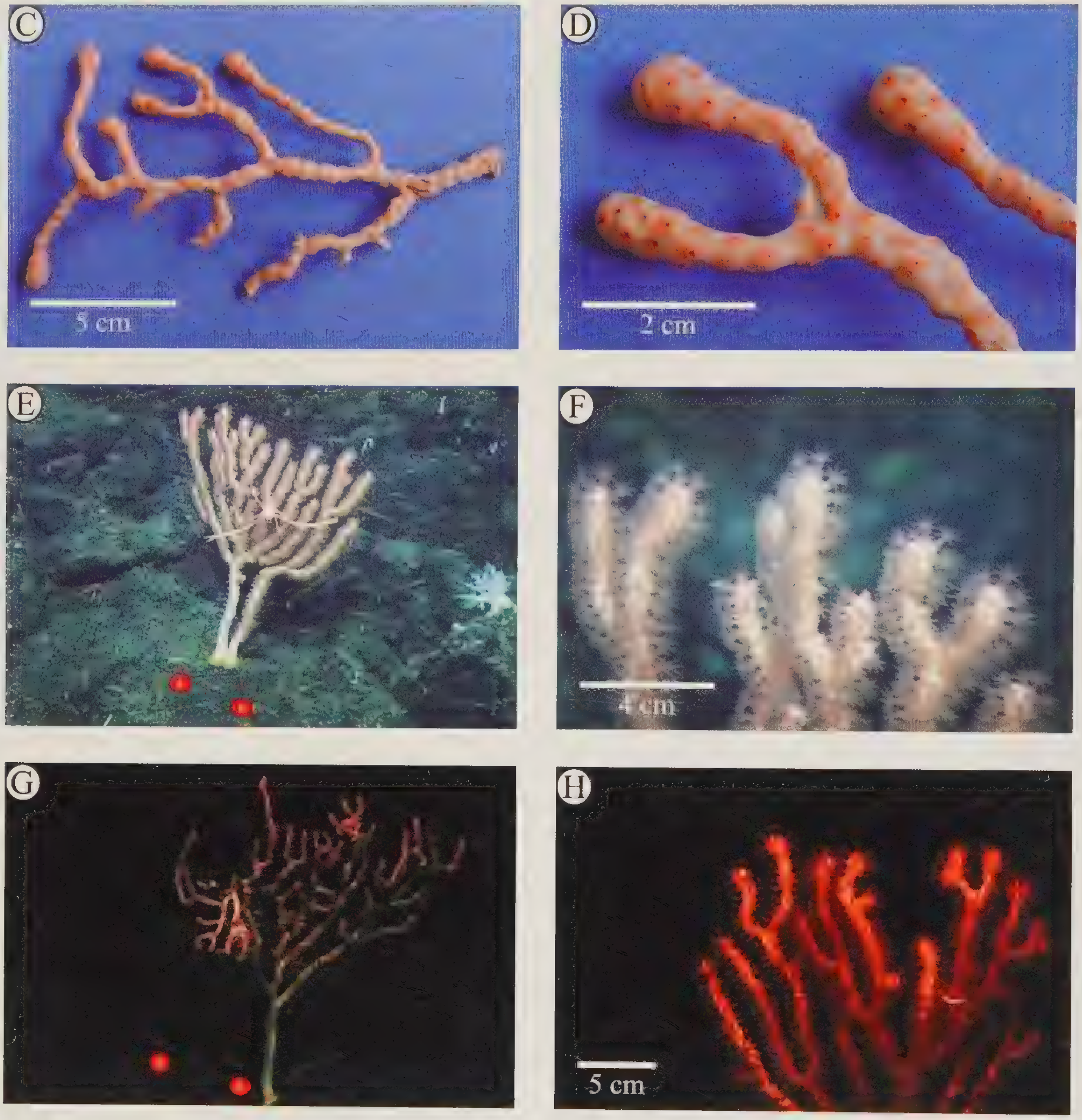
A map of the North Pacific Ocean showing the distribution of *Paragorgia jamesi* (+) in Alaska waters.

m. Elsewhere – continental slope habitats at depths between 1168 and 1194 m.

Photos A) A *P. jamesi* specimen (yellow morph) collected in the eastern GOA at a depth of approximately 500 m. B) A close-up view of the same specimen in photo A. C) A preserved (in ethanol) branch from a *P. jamesi* colony (USNM 1075764; pink morph) collected on Pratt Seamount at a depth of 920 m. D) A close-up view of the same specimen in photo C. E) A *P. jamesi* colony (yellow morph) photographed on Dickens Seamount at a depth of 751 m. F) A close-up view of the same colony in photo E with polyps fully extended. G) A *P. jamesi* colony (USNM 1661898; pink morph) sampled on Giacomini Seamount at a depth of 762 m. H) A close-up view of the same colony in photo G with polyps fully extended. The distance between the red laser marks in photos E and G is 10 cm.



2. *Paragorgia jamesi* Herrera and Shank, 2016 (continued)


C
5 cm
D
2 cm
E
F
4 cm
G
H
5 cm

3. *Paragorgia arborea* var. *pacifica* Verrill, 1922

Background At one time three separate *Paragorgia* taxa were recognized in the North Pacific Ocean including Alaska—*Paragorgia arborea*, *P. pacifica* Verrill, 1922, and *P. nodosa* Koren and Danielssen, 1883. *Paragorgia arborea* was originally described from the North Atlantic Ocean (Linnaeus, 1758), then later Kinoshita (1913), Hickson (1915), and Verrill (1922) designated specimens collected in the North Pacific Ocean, including Alaska waters, as *P. arborea*. Verrill (1922) described *P. pacifica* from British Columbia at the same time that he recognized *P. arborea* from Alaska waters and expressed uncertainty whether *P. pacifica* was actually a variety of *P. arborea*; he noted that additional examination of the sclerites was warranted. Herrera et al. (2012) found genetic differentiation of the North Pacific Ocean *P. arborea* populations relative to all other world populations (South Pacific, Indian, and North Atlantic Oceans) and suggested that they may represent a sub-species. Finally, Herrera and Shank (2016) synonymized *P. arborea* (in the North Pacific Ocean region only) with *P. pacifica*.

The WoRMS Editorial Board (2022) currently recognizes only *P. pacifica* as a valid species. However, since *arborea* was synonymized with *pacifica*, *arborea* has precedence as the senior synonym. Accordingly, we adopt the designation by Horvath (2019) for the species as *P. arborea* var. *pacifica*.

We do not dispute the validity of a single designation as *P. arborea* var. *pacifica* but have chosen to provide a separate species profile for the morph that would have traditionally been listed as *P. nodosa* to highlight both the differences and overlap in form, biogeography, and ecology. Additionally, since the systematics for this species complex seems incomplete, recalcitrant, and likely to be refined again with advances in molecular DNA techniques (see Herrera and Shank, 2016), this presentation might aid in facilitating future work with the species complex.

Description The original description by Verrill (1922) for *P. pacifica* indicated that colonies are more delicate and smoother than North Atlantic *P. arborea* specimens and that the sclerites differ considerably. The medulla is finer and more compact and the longitudinal canals are relatively smaller. The stem and axis are quite distinct, harder, more compact, and a lighter color than the surrounding middle layer, with larger and longer sclerites, some forked, and with fewer warts. The coenenchyme contains an abundance of smaller sclerites, mostly very irregular warty spindles of various sizes. The type specimen was collected in Jervis Inlet, southern British Columbia, at a depth of 18 m. Note that this is the same location and approximate depth where *P. stephencairnsi* have more recently been documented (see that species' profile, photo F).

The most recent description for *P. arborea* by Sánchez (2005) was written for the species worldwide, including Alaska, and described robust colonies up to several meters high with bubble-like concentrations of autozooids. Dense and regular accumulations of autozooid nodules are largely restricted to distal and lateral branches, whereas the distal main stem and branches are without nodules. The inter-nodular surface is covered with numerous and uniformly distributed tiny siphonozooids, giving the colony a granular texture when the apertures are closed. The medulla is perforated by 5–7 main-stem canals in terminal branches, surrounded by both red and colorless spindles; the outer medulla has colorless sclerites and numerous smaller canals. Polyps are completely retractable into small conical calyces. Tentacle sclerites are blunt, stubby ovals with some pointed-like spindles. Surface sclerites are small, uniform 6-radiates; medulla sclerites are long, thin spindles.

Paragorgia arborea var. *pacifica* is one of the most colorful Alaska corals, along with *Muriceides nigra*. The color of the coenenchyme is uniform and the predominant color is pink to light red, but Aleutian Island specimens may also be white, salmon orange, or yellow. The latter three color-phases are more common in the shallower part (<305 m depth) of the species' range in the Aleutian Islands, and those specimens appear to have a contagious distribution (senior author, unpubl. data). The medulla is typically creamy white but occasionally the same color as the coenenchyme or a slightly lighter shade. Similarly, the polyps and tentacles are typically a creamy white but are often pink in specimens with pink or reddish coenenchyme. Seamount colonies are strictly light red to crimson red. Specimens retain their natural coloration in ethanol but the color dulls somewhat in dried specimens.

Remarks *Paragorgia arborea* var. *pacifica* is often found in complex habitats and is an excellent indicator species of coral garden habitat. *Paragorgia arborea* var. *pacifica* is also the second largest coral species in Alaska, growing to more than 2 m in height and width with basal diameters up to 20 cm, but massive specimens have been collected near New Zealand (Tracey et al., 2003) measuring approximately 75 cm in basal diameter. Growth rates are largely unknown for *Paragorgia* species given the lack of a calcified skeleton, but limited evidence suggests axial (linear) growth rates for North Atlantic *P. arborea* specimens of 1 cm/year (Mortensen and Mortensen, 2005), while Sherwood and Edinger

(2009) estimate axial growth rates of 1.62 cm/year and ages of up to 80 years old.

Paragorgia arborea var. *pacifica* produces copious amounts of mucus and consequently supports a rich microbial community (Gray et al., 2011) and numerous associated fauna including ophiuroids, amphipods, and the shrimp *Heptacarpus moseri* (in Zhemchug Canyon). Seamount specimens are often used by the sternostylid crab *Sternostylus iaspus* as platforms for suspension feeding and support large numbers of ophiuroids including the large *Asteronyx* sp. (up to 15 per colony) and polychaetes (often the same color as the host colony coenenchyme).

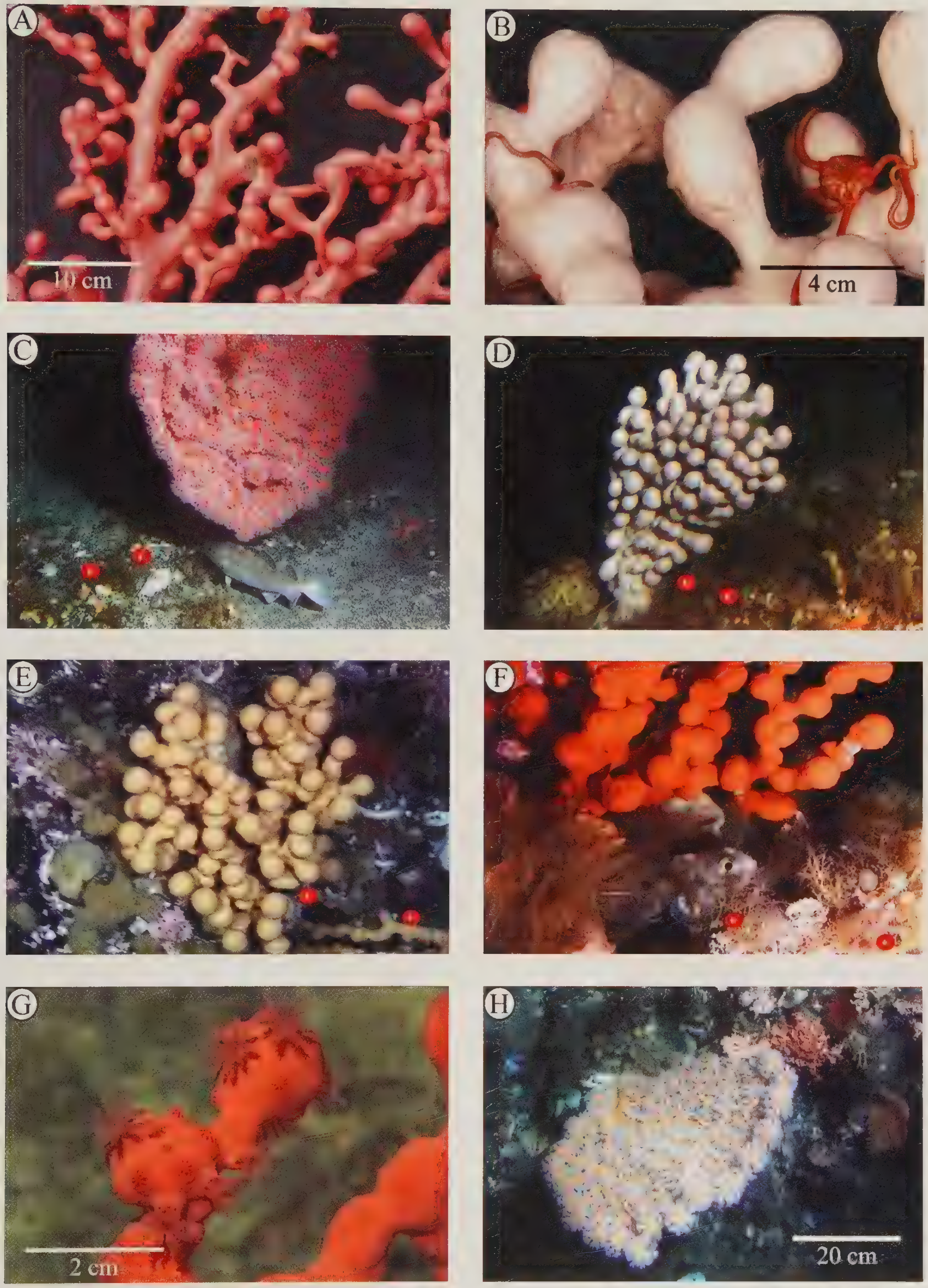
The coenenchyme and medulla is composed almost entirely of high-magnesium calcite (9.1–10.7 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Widespread and locally abundant. In Alaska – specimens have been collected in the western Gulf of Alaska (near Chirikof Island to Shumagin Bank), the Aleutian Islands (near Unalaska Island to west of Attu Island) including Bowers Bank, the eastern Bering Sea (north of Unimak Pass to Pervenets Canyon), and on Dickens (video observations only), Welker, Pratt, Giacomini, Murray, and Patton Seamounts in the Gulf of Alaska Seamount Province (Fig. 11-4). Elsewhere – the North Pacific Ocean from the Commander Islands (Kamchatka, Russia) to Monterey Bay and Davidson Seamount (California). *Paragorgia arborea* is reported in the North Atlantic Ocean from Trondheim Fjord (Norway), the Faroe Islands, Iceland, and Greenland (Tendal, 1992). Additional records indicate a patchy distribution from southern Greenland (Davis Strait) to off North Carolina. This species also occurs in the South Pacific Ocean near New Zealand.

Paragorgia arborea var. *pacifica* overlaps spatially with *P. jamesi*, *Paragorgia* sp. A, and *Paragorgia* sp. B on seamounts in the Gulf of Alaska Seamount Province.

Habitat In Alaska – grows on bedrock, fractured bedrock and boulders, and occasionally on large cobbles and hexactinellid sponge skeleton (*Farrea* spp. and *Heterochone* sp.), in areas of moderate current, at depths between 21 and 1115 m. These observations are both the shallowest and deepest (Stone, 2014) for the species. Elsewhere – likely similar habitat to that in Alaska at depths near 102 m near the Commander Islands (Kamchatka, Russia), 30–1168 m off British Columbia, 750 m off Oregon, and 274–650 m off California.

Photos A) A fresh whole *P. arborea* var. *pacifica* colony (partial view only) (USNM 1106086) collected in Adak Strait, central Aleutian Islands, at a depth of 90 m. B) A close-up view of a fresh *P. arborea* var. *pacifica* specimen (USNM 1011097) collected northwest of Adak Island in the central Aleutian Islands at a depth of 160 m. C) A *P. arborea* var. *pacifica* colony photographed near Little Tanaga Island in the central Aleutian Islands at a depth of 156 m. A Pacific cod (*Gadus macrocephalus*) takes shelter under the colony. D) A *P. arborea* var. *pacifica* colony photographed near Adak Island at a depth of 138 m. E) A *P. arborea* var. *pacifica* colony photographed northwest of Tanaga Island in the central Aleutian Islands at a depth of 115 m. F) A *P. arborea* var. *pacifica* colony (USNM 1484211) photographed on Amchixtam Chaxsxii in the central Aleutian Islands at a depth of 212 m. A darkfin sculpin (*Malacocottus zonurus*) takes shelter under the colony. The distance between the red laser marks in photos C–F is 20 cm. G) A close-up view of a *P. arborea* var. *pacifica* colony (USNM 1075766) prior to sample collection on Welker Seamount at a depth of 1114 m. H) A *P. arborea* var. *pacifica* colony photographed with polyps fully extended near the Delarof Islands (Amatignak Island) in the central Aleutian Islands at a depth of approximately 160 m.


A
10 cm
B
4 cm
C
D
E
F
G
2 cm
H
20 cm

3. *Paragorgia arborea* var. *pacifica* Verrill, 1922 (continued)

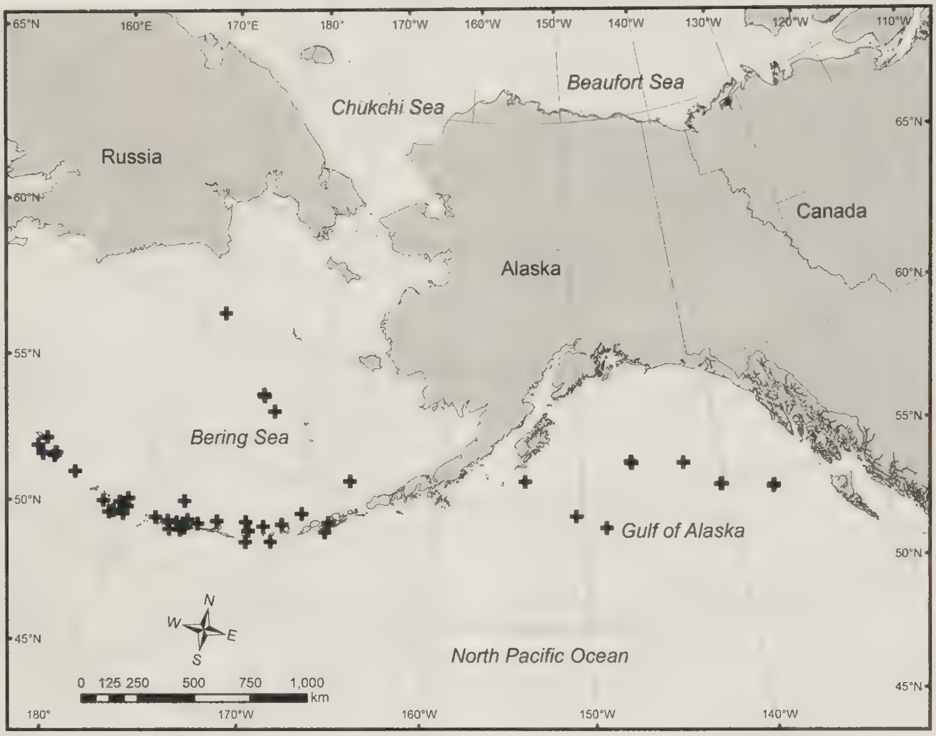

Russia
Chukchi Sea
Beaufort Sea
Alaska
Canada
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000
km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
180°
170°W
160°W
150°W
140°W

Figure 11-4

A map of the North Pacific Ocean showing the distribution of *Paragorgia arborea* var. *pacifica* (+) in Alaska waters. Note that records for the *nodosa* morph are illustrated in Fig. 11-5; together the two figures show the whole distribution for *P. arborea* var. *pacifica*.

3A. *Paragorgia arborea* var. *pacifica* morph *nodosa*

Background The original description for *Paragorgia nodosa* by Koren and Danielssen (1883) indicates that the type specimen was collected off Norway at a depth of 549 m. Subsequently, Nutting (1912) provided a detailed re-description of the species for a specimen collected on Bowers Ridge (Aleutian Islands) at a depth of 655 m during the 1906 U.S. Fisheries Steamer *Albatross* expedition. After later re-examination of Nutting's specimen, Broch (1957) synonymized *P. nodosa* with *P. arborea*, concluding that the two species were identical. Broch (1957) did not explicitly state how they were identical but we assume he meant with regard to the complement and morphometry of the sclerites.

Comparison *Paragorgia arborea* var. *pacifica* and the morph *nodosa* have very similar geographical distributions in Alaska (Figs. 11-4 and 11-5) and do overlap slightly in bathymetric distribution, especially on several seamounts in the Gulf of Alaska Seamount Province, but otherwise are fairly spatially discrete. The two taxa (one is a morph, the other a variety) differ from each other with regard to several gross morphological characteristics. In general, *Paragorgia arborea* var. *pacifica* is more robust, arborescent, obviously fan-shaped, and much less nodulated than the morph *nodosa*. Nodules are mostly restricted to the branch tips or branch nubs on the secondary branches. The branches and nodules are smooth and the autozooid apertures are relatively small and not raised. Colonies often exceed 1 m in height and 1 m in width.

Description (Adapted from Koren and Danielssen, 1883) The original description for the type specimen collected off Norway (549 m depth) indicated that it was tree-like with two main branches. The branches were knotty and densely populated with polyps and zooids. The branches are naked and smooth and slender between the nodes or nodules. The polyps are short, retractile, and contain numerous sclerites.

Nutting's (1912) description of an additional colony indicated that it consisted of a thick stem bearing branches on all sides; some were short clavate branches while others were merely irregular nodules (up to 14 mm in diameter) seated immediately on the stem. Most polyps were situated on the nodules; he suggested that a few on the main stem or branches might be the beginning of a new branch or nodule. Calyces are low verrucae with eight-lobed margins and 3 mm in height and 6 mm in diameter at the base. The polyps are completely retractile and the tentacles bear longitudinal spindles. Siphonozooids are numerous but very small. The medulla consists almost entirely of small spindles traversed by large conspicuous longitudinal canals. Sclerites are mostly small, irregular tuberculate spindles and a few irregular minute double heads and crosses. The polyp sclerites are red and the medullar sclerites are white.

We have no doubt why Nutting (1912) regarded the specimen as *P. nodosa* since most specimens collected deeper than about 500 m in the Aleutian Islands, in general, are stouter, less arborescent, and much more nodulated. Nodules are more prominent, well defined, and not restricted to the branch tips or branch nubs on the secondary branches. The branches and nodules have a rough appearance because the autozooid apertures are large and raised on conical calyces. The coenenchyme on the primary branches is sometimes coarsely textured and linear striations are apparent. Colonies rarely exceed 1 m in height and 1 m in width. Colonies are predominantly various shades of red, sometimes with a purple hue in situ (Aleutian Islands) and orange to crimson red elsewhere. Polyps are almost always the same color as the coenenchyme. Specimens generally retain their color in ethanol, but the color commonly fades when dried; red specimens fade to orangish-red.

Remarks *Paragorgia arborea* var. *pacifica* morph *nodosa* is often found in complex habitats and is an excellent indicator species of coral garden habitat. The scarlet king crab (*Lithodes couesi*) is occasionally observed on colonies on seamounts in the Gulf of Alaska Seamount Province (see photo F on page 181), and eelpouts (including *Puzanovia rubra*) deposit and guard egg masses on colonies in the Aleutian Islands (see photo G on page 181). Other associated fauna include polynoid polychaetes and pleustid amphipods (Watling and Stone[7]), the ophiuroids *Ophiacantha* sp. and *Asteronyx* sp., and the sternostylid crab *Sternostylus iaspus*.

Distribution Widespread and locally common. In Alaska – specimens have been collected in the western Gulf of Alaska off Chirikof Island to Shumagin Bank, the Aleutian Islands south of Amlia Island to west of Buldir Island including Bowers Bank, the eastern Bering Sea from Pribilof Canyon to Pervenets Canyon, and Dickens, Welker, and Pratt Seamounts in the Gulf of Alaska Seamount Province (Fig. 11-5). Elsewhere – unknown.

Morph *nodosa* overlaps spatially with *P. jamesi*, *P. arborea* var. *pacifica*, *Paragorgia* sp. A, and *Paragorgia* sp. B on seamounts in the Gulf of Alaska Seamount Province.

Habitat In Alaska – grows on bedrock, fractured bedrock, boulders, large cobbles, and occasionally on

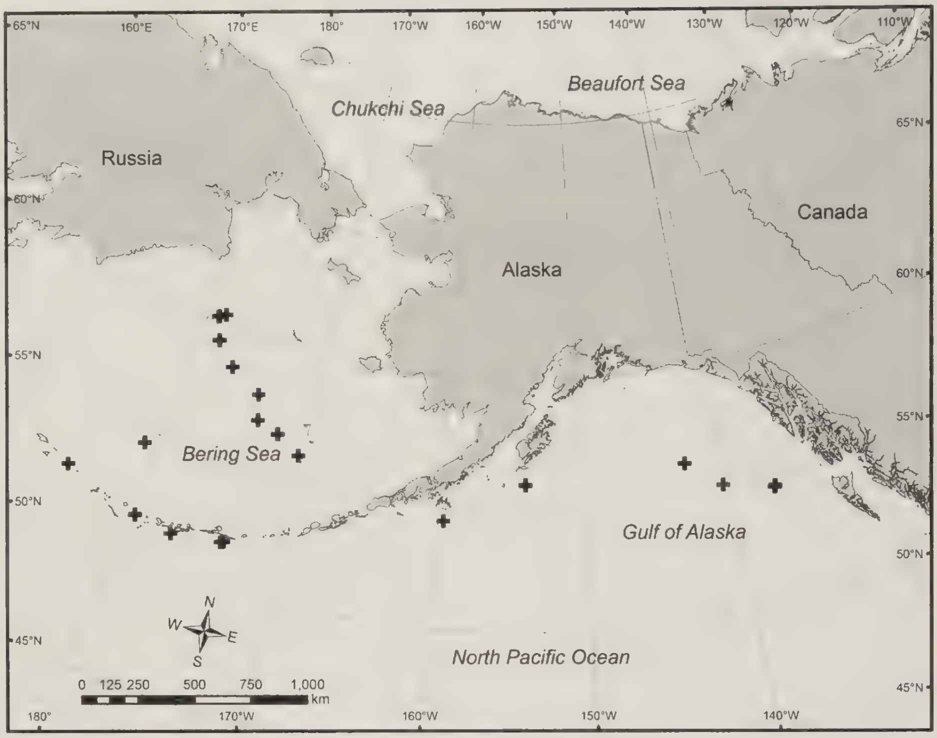
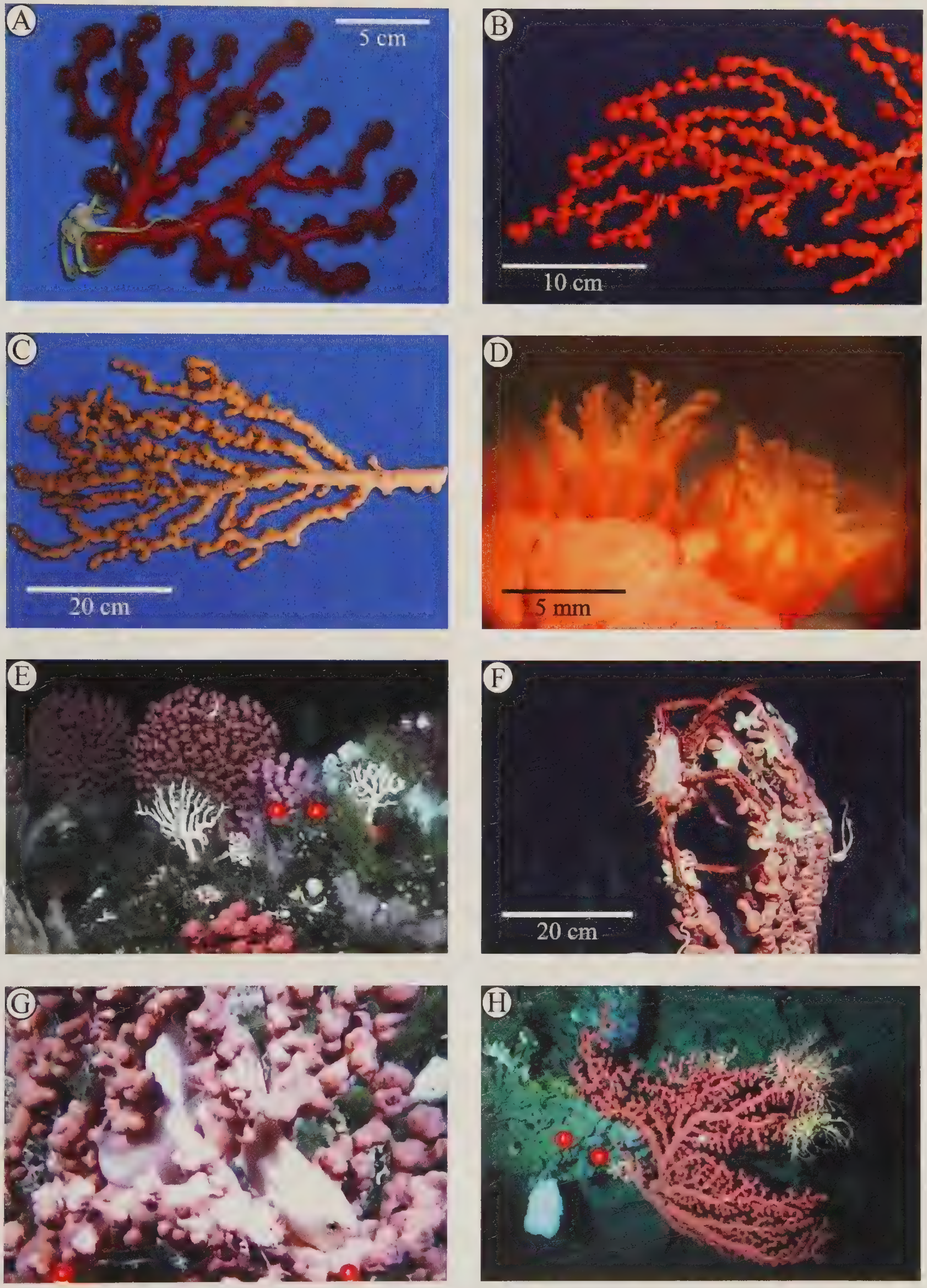


Figure 11-5

A map of the North Pacific Ocean showing the distribution of *Paragorgia arborea* var. *pacifica* morph *nodosa* (+) in Alaska waters.

hexactinellid sponge skeleton (*Farrea* spp.), in areas of moderate current, at depths between 299 and 2022 m. Depth ranges for each region of Alaska are 691–1143 m in the western GOA, 470–2022 m in the Aleutian Islands, 299–1077 m in the eastern Bering Sea, and 754–1761 m in the Gulf of Alaska Seamount Province.

Photos A) A fresh whole *P. arborea* var. *pacifica* morph *nodosa* colony (USNM 1123935) collected southwest of Amlia Island in the central Aleutian Islands at a depth of 844 m. B) A fresh branch complex from a *P. arborea* var. *pacifica* morph *nodosa* colony (USNM 1484212) collected in Zhemchug Canyon in the eastern Bering Sea at a depth of 987 m. C) A dried whole *P. arborea* var. *pacifica* morph *nodosa* colony (USNM 1484223) collected east of Chirikof Island in the western GOA at a depth of 691 m. D) A fresh *P. arborea* var. *pacifica* morph *nodosa* specimen (USNM 1123938) collected in Amchitka Pass in the central Aleutian Islands at a depth of 746 m, showing the detail of the polyps and tentacles. E) A coral garden dominated by *P. arborea* var. *pacifica* morph *nodosa* colonies on Amchixtam Chaxsxii in the central Aleutian Islands at a depth of 921 m. F) A *P. arborea* var. *pacifica* morph *nodosa* colony (USNM 1075745) prior to sample collection on Dickens Seamount at a depth of 849 m. A scarlet king crab uses the colony as a perch. G) A *P. arborea* var. *pacifica* morph *nodosa* colony photographed in northern Amchitka Pass, central Aleutian Islands, at a depth of 798 m. An eelpout (probably *Puzanovia rubra*) uses the colony as shelter and displays cryptic coloration. H) A *P. arborea* var. *pacifica* morph *nodosa* colony photographed growing on siltstone southwest of Amlia Island, central Aleutian Islands, at a depth of 2022 m—the deepest known *P. arborea* var. *pacifica* morph *nodosa* colony in the world. The distance between the red laser marks is 10 cm in photos E and G and 20 cm in photo H.


A
5 cm
B
10 cm
C
20 cm
D
5 mm
E
F
20 cm
G
H

4. *Paragorgia stephencairnsi* Sánchez, 2005

Description (Revised morphological diagnosis from Herrera and Shank, 2016, amended from Sánchez, 2005) Colonies have robust branches with a white, pink, or red cortex; white or pink medulla; white, pink, red, or purple autozooid apertures. Numerous conical, semi-closed, autozooid polyp apertures are uniformly/randomly distributed on all branch surfaces. Siphonozooid apertures are tightly closed and not observable to the naked eye. The medulla in terminal branches has six or seven major canals. Surface sclerites are mostly seven- and eight-radiates, with long (>0.01 mm) lobulated, smooth rays. Medulla sclerites are elongated, forked or irregular spindles, highly ornated, and usually less than 0.3 mm in length.

With regard to the Alaska specimens, two distinct morphs conform to this species. One specimen (see photos A and F) is without doubt the same as the shallow-water (≤41 m) specimens from British Columbia, but the others found in deeper water are similar in morphological characteristics but quite different in form. The former morph is almost perfectly fan-shaped, planar but obviously concave, with branching to the 4th order and up to 35 branch tips. The colony is about 48 cm in height and width. The colony divides into two main stems (5 cm diameter) immediately above the holdfast and then the branches are of uniform dimension (1.3–1.5 cm diameter), not flattened, with clavate branch tips and some swellings along the branch length. Autozooids are located over the entire colony surface but are much more abundant on the front or outer side, presumably the side of the colony facing the predominant current. Siphonozooids are not obvious to the naked eye. Anthocodiae are randomly arranged throughout the colony, not obviously in linear rows, only slightly raised, and the polyps are completely retractile but the apertures are variably closed. The colony is supported by a large (about 11 cm in height and width), stout asymmetrical holdfast that is white in color. The color of the colony is a uniform dark pink to red; the polyps are white. Holdfasts are strong but the branches are rather brittle and easily broken.

The other/latter morph is similar in every way to the former except colonies are sparsely and irregularly branched (see photos G and H). Colonies have a stout appearance and branch in a single plane and only to the 3rd order. The color of the colony is a uniform crimson-red in situ and when freshly collected, but dried colonies are orange-red; the color of the polyps is unknown but presumed to be white. Holdfasts are strong but the branches are rather brittle and easily broken.

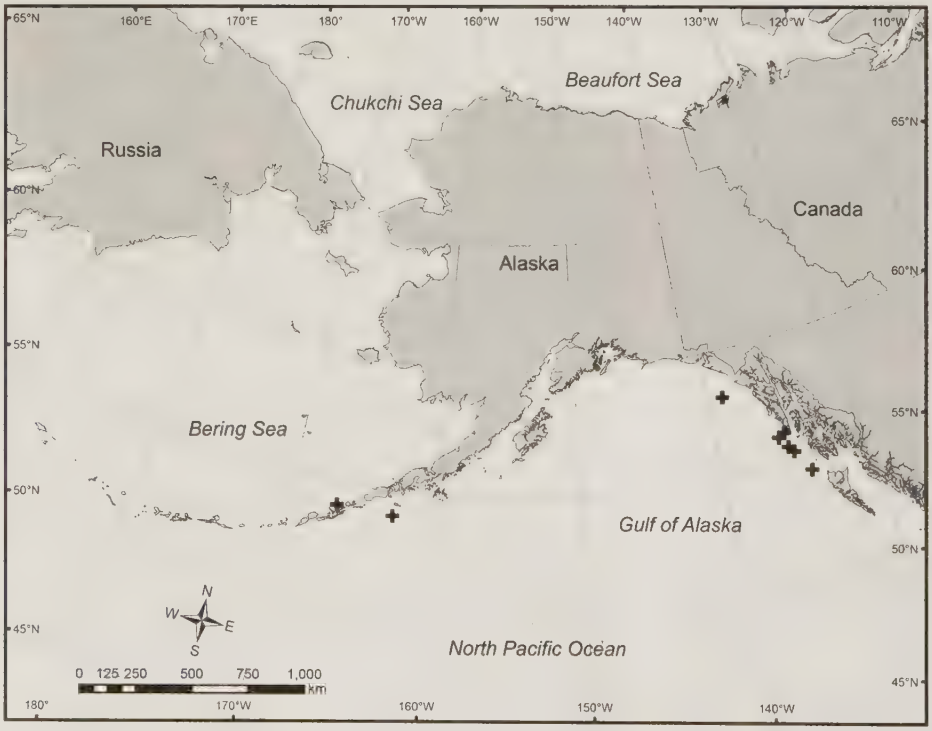


Figure 11-6

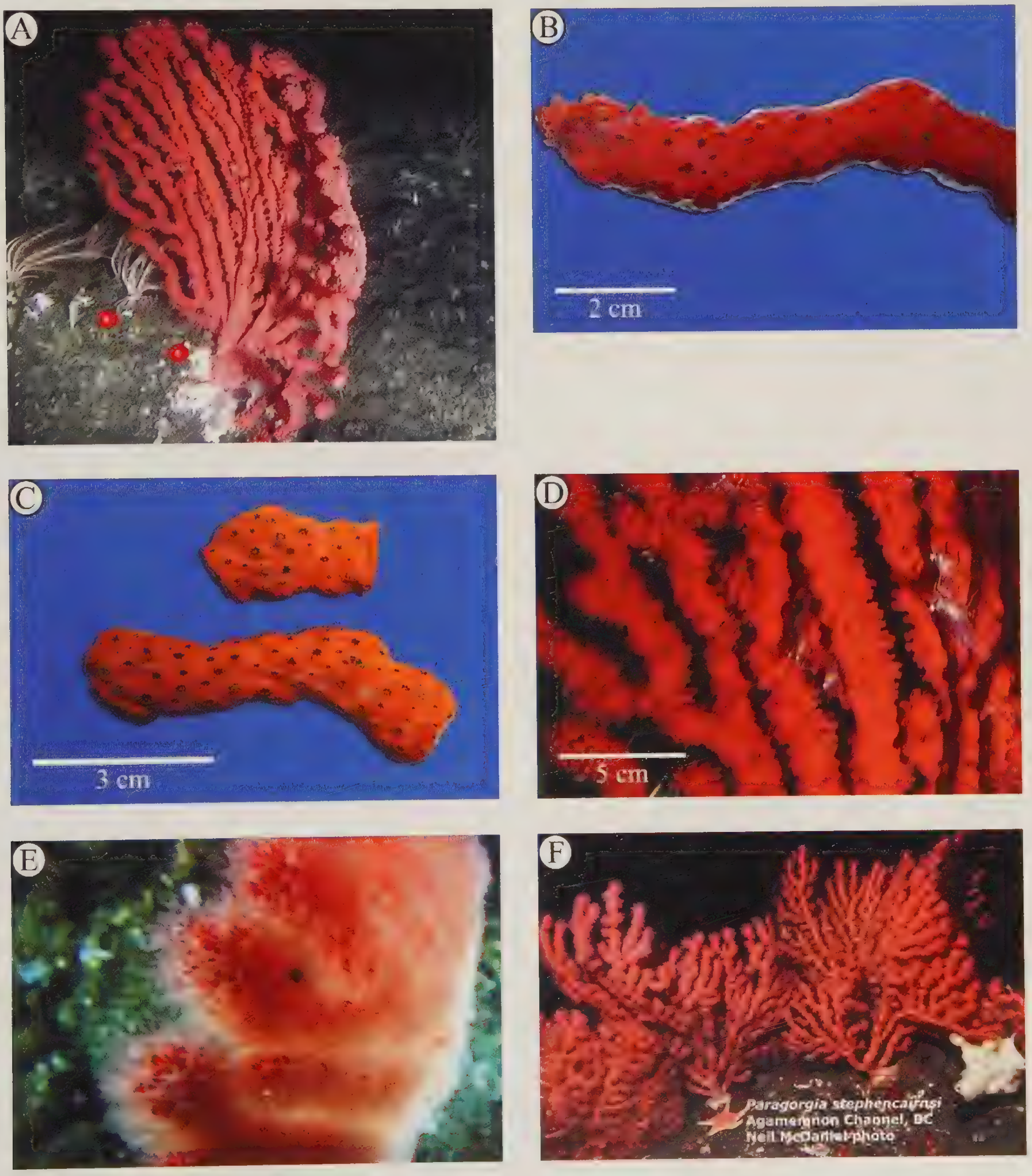
A map of the North Pacific Ocean showing the distribution of *Paragorgia stephencairnsi* (+) in Alaska waters.

Remarks Associates include pandalid shrimp (see photo D).

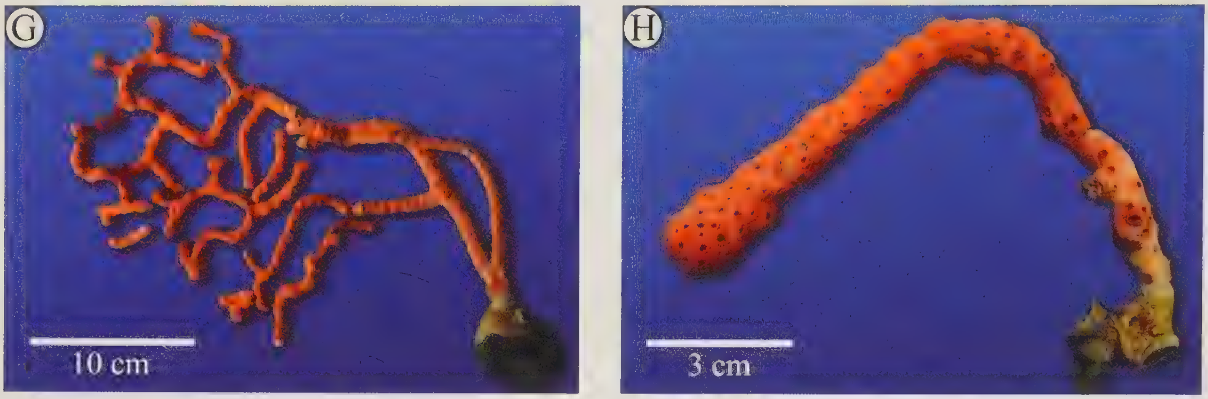
Distribution Rare. In Alaska – found mostly on the continental slope and upper shelf in the eastern GOA but there are a few records from the western GOA and the easternmost part of the Aleutian Islands (Fig. 11-6). This species does not appear to occur in the Gulf of Alaska Seamount Province. Elsewhere – the holotype was collected in Georgia Strait, southern British Columbia, at a depth of approximately 350 m. Specimens have been collected throughout much of British Columbia and on Fieberling Guyot and Piggy Bank Seamount off southern California.

Habitat In Alaska – occurs singly in rough, rocky areas (bedrock, fragmented bedrock, and cobbles) with moderate current, at depths between 171 and 741 m. Elsewhere – occurs singly or in small thickets in rocky areas at depths between 32 and 490 m.

Photos A) A *P. stephencairnsi* colony (USNM 1484215) prior to sampling on Shutter Ridge, eastern GOA, at a depth of 171 m. The distance between the red laser marks is 10 cm. B) A fresh branch tip collected from the same colony in photo A. C) The same specimen in photo B, dried. D) The same colony in photo A in situ prior to collection, with polyps retracting. E) The same colony in photo A in situ prior to collection, with polyps fully extended. F) A small thicket of *P. stephencairnsi* at a depth of 40 m in Jervis Inlet, southern British Columbia. G) A fragmented but whole dried *P. stephencairnsi* colony (USNM 1484201) collected in the eastern GOA at a depth of 513 m. H) Large dried fragments of a *P. stephencairnsi* colony (USNM 1484203) collected in Dixon Entrance, eastern GOA, at a depth of 427 m.



4. *Paragorgia stephencairnsi* Sánchez, 2005 (continued)



5. *Paragorgia* sp. A

Description Colonies are almost always planar and fan-shaped; the largest colonies are about 50 cm in height and 60 cm in width. Colonies appear rubbery but are actually quite fragile. Colonies are not robust, but are typically highly branched, with branches that rarely exceed 1 cm in diameter. Branching starts very close to a strong holdfast that is irregularly shaped, large (8 cm in diameter), white in color, and occasionally covered with a golden-brown stain. Nodules envelope the entire branch or are located terminally on very short branches and contain large (up to 3.6 mm in height and diameter), characteristically conical-shaped calyces that are irregularly spaced. The anthocodiae are often white-tipped in situ and in preserved specimens; the tips of the white (or very light pink) polyps appear to be completely retractable but often are not. The siphonozooids are relatively large (approximately 0.8 mm in diameter) and abundant on all surfaces, giving the colony a rough or warty appearance. The sclerites for colonies we have designated as *Paragorgia* sp. A have not yet been examined. Colonies are a uniform, brilliant pinkish or crimson-red color in situ and a slightly lighter hue in ethanol.

Remarks This species is known from five collected specimens and several observations made in situ. Herrera and Shanks (2016) used restriction site-associated DNA sequencing techniques to identify four of the collected specimens as *P. arborea* var. *pacifica* and one only to genus. *Paragorgia* sp. A does bear a morphological likeness to *P. arborea* var. *pacifica* morph *nodosa* (that is included in the *P. arborea* complex of Herrera and Shanks, 2016), but there are obvious morphological differences that we believe warrant listing it separately until additional taxonomic work is done. Furthermore, *Paragorgia* sp. A and *P. arborea* var. *pacifica* morph *nodosa* are not geographically or bathymetrically discrete, even occurring within meters of each other, providing additional evidence that they may be different species, subspecies, or varieties and not ecomorphs (i.e., a locally adapted population of an intraspecific group having distinctive characteristics resulting from selective pressures of the local environment).

This species hosts hippolytid shrimps, sternostylid crabs (*Sternostylus iaspus*), and ophiuroids including *Asteronyx* species.

Distribution Locally common. In Alaska – found only in the Gulf of Alaska Seamount Province (Dickens, Welker, Pratt, Giacomini, and Murray Seamounts; Fig. 11-7). Elsewhere – unknown.

Paragorgia sp. A overlaps spatially with *P. jamesi*, *P. arborea* var. *pacifica*, *P. arborea* var. *pacifica* morph *nodosa*, and *Paragorgia* sp. B on seamounts in the Gulf of Alaska Seamount Province.

Habitat In Alaska – grows mostly on bedrock and fractured bedrock and occasionally on boulders, large cobbles, and hexactinellid sponge skeletons (*Heterochone* sp.). Found singly or in tight patches (up to 10 colonies together) in generally rough habitat and at

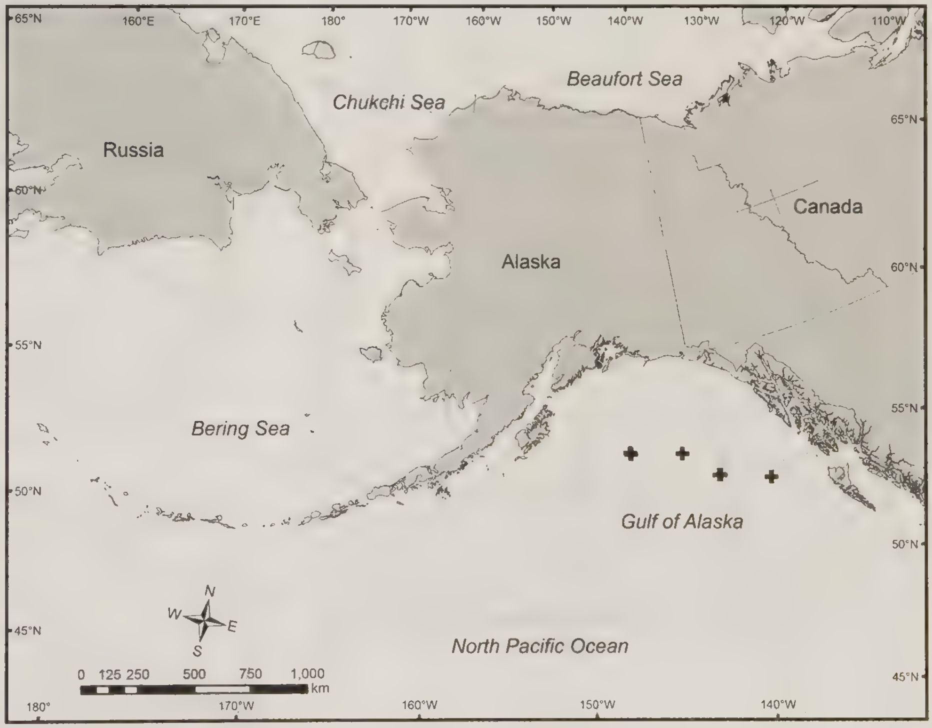
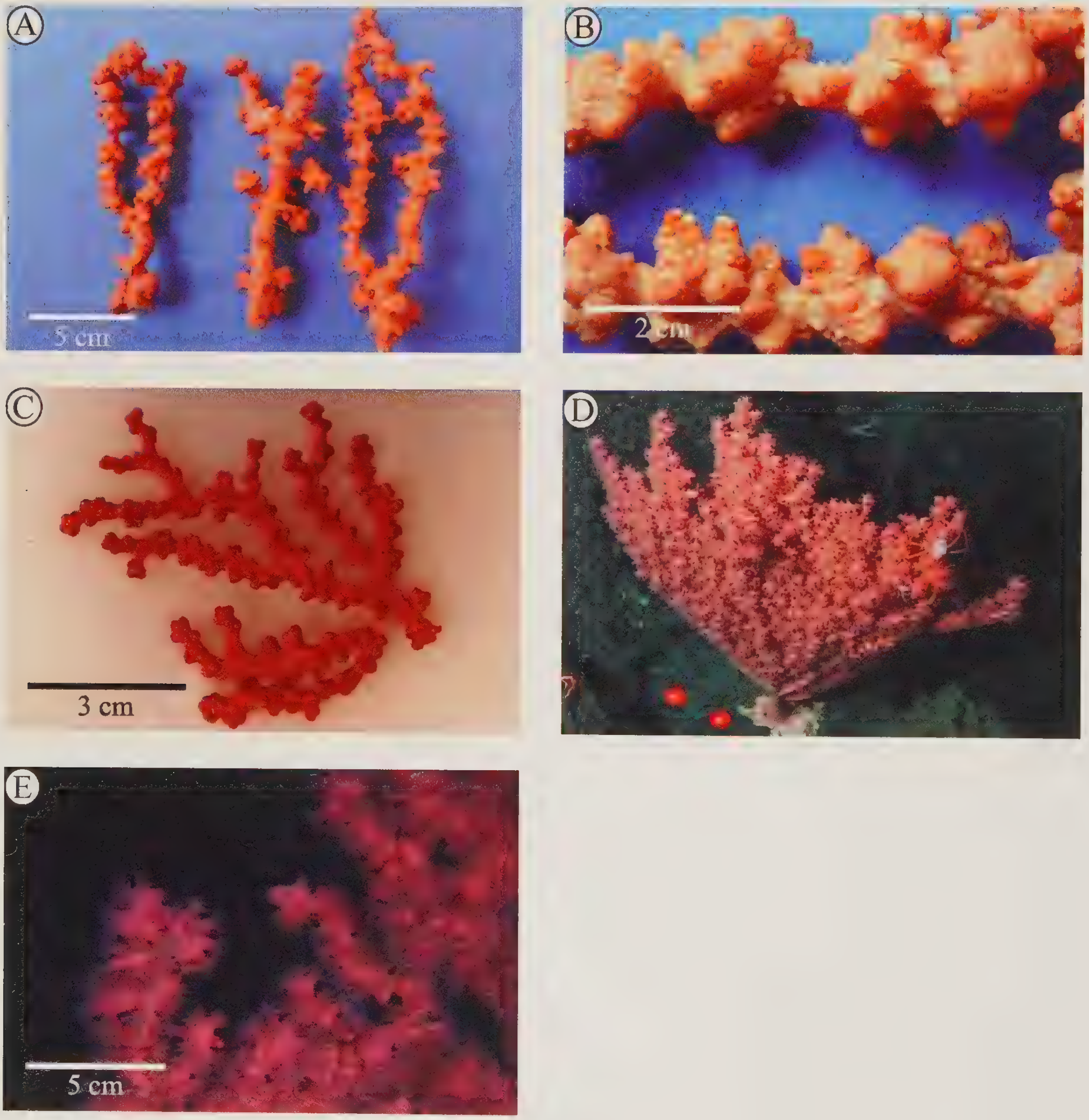


Figure 11-7

A map of the North Pacific Ocean showing the distribution of *Paragorgia* sp. A (+) in Alaska waters.

depths between 746 and 1112 m. Observed as shallow as 716 m on video footage collected on Giacomini Seamount.

Photos A) Preserved (in ethanol) branches of a *Paragorgia* sp. A colony (USNM 1075746) collected on Welker Seamount at a depth of 781 m. B) A close-up view of the same specimen in photo A. C) Fresh branches of a *Paragorgia* sp. A colony (USNM 1661895) collected on Giacomini Seamount at a depth of 746 m. D) A *Paragorgia* sp. A colony (USNM 1075751) collected on Welker Seamount at a depth of 785 m. The colony is surrounded by hexactinellid skeleton (*Farrea* sp.) and hosts a sternostylid crab (*Sternostylus iaspus*). The distance between the red laser marks is 10 cm. E) A close-up view of the same colony in photo D.



6. *Paragorgia* sp. B

Description Colonies are almost always planar, fan-shaped, and convex, with an obvious front and back side; the largest colonies are about 47 cm in height and 58 cm in width. Colonies are often highly branched and appear delicate but are actually somewhat rubbery and difficult to tear when collected. Main branches are robust and often exceed 1 cm in diameter. Branching starts very close to a strong holdfast that is irregularly shaped, medium-sized (up to 6 cm in diameter), and white in color, occasionally covered with a golden-brown stain. Nodules are absent in *Paragorgia* sp. B; autozooids are directly on the branches and predominantly on the front and lateral sides. Autozooids are rarely present on the back side of the colony. Siphonozooids are moderately abundant and located all over the branches. The short round calyces are irregularly placed and bear large polyps that do not appear to be completely retractile. The anthocodiae are often white-tipped in situ and in preserved specimens; undoubtedly these are the tips of the exposed white (or light pink) polyps. Linear striations are visible in the coenenchyme on the back side of the colony. The sclerites for colonies we have designated as *Paragorgia* sp. B have not yet been examined. Colonies are pink in situ and a slightly lighter hue in ethanol. The branches are a lighter shade of pink than the calyces and are lighter on the back side than on the front side, even appearing white in some specimens. Specimens hold their natural colors when preserved in ethanol.

Remarks This species is known from 11 collected specimens and about 90 observations made in situ. Of the 11 collected specimens, Herrera and Shanks (2016), using restriction site-associated DNA sequencing techniques, identified eight as an unknown species of *Paragorgia* and two as *P. arborea*. This species is quite different from any other *Paragorgia* species known from Alaska. It co-occurs with all other *Paragorgia* species found on the same seamounts and in particular with *Paragorgia* sp. A.

This species is very similar in gross morphology (e.g., branching pattern) and color to *Hemicorallium* sp., and the two species could easily be mistaken for each other in situ. Fortunately, they only co-occur on Patton Seamount and have separate, non-overlapping depth ranges there.

This species hosts hippolytid shrimps and ophiuroids including *Asteronyx* species. Sections of damaged specimens are often covered with hydroids, small actiniarians, and zoantharians (*Zibrowius* sp.).

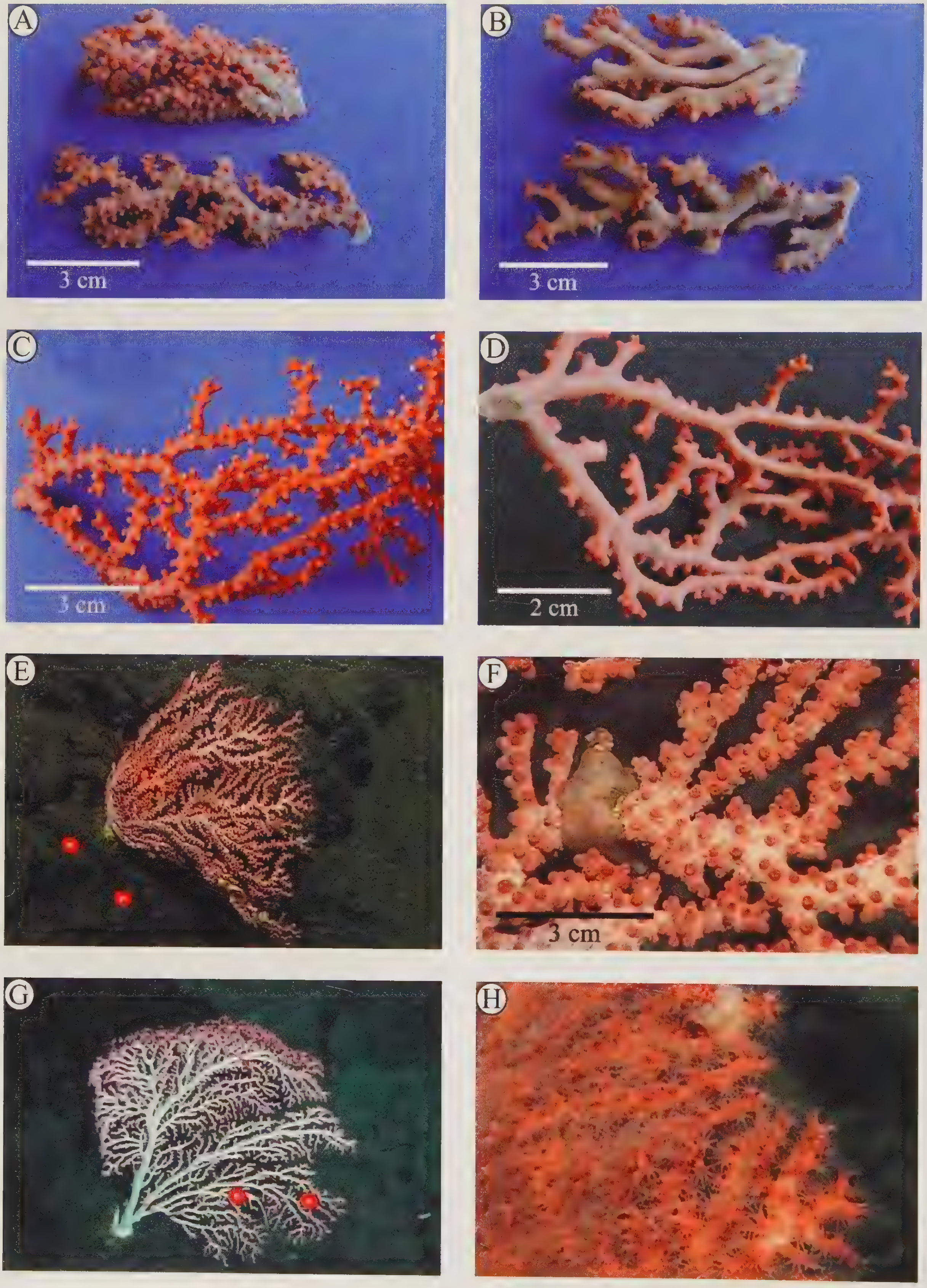
Distribution Uncommon. In Alaska – known only from the Gulf of Alaska Seamount Province (Welker, Pratt, Quinn, Giacomini, and Murray Seamounts; Fig. 11-8). Particularly abundant on Pratt and Welker Seamounts. Elsewhere – unknown.

Paragorgia sp. B overlaps spatially with *P. jamesi*, *P. arborea* var. *pacifica*, *P. arborea* var. *pacifica* morph *nodosa*, and *Paragorgia* sp. A on seamounts in the Gulf of Alaska Seamount Province.

Habitat In Alaska – typically found singly on bedrock but also fractured bedrock, boulders, large cobbles, and hexactinellid skeleton (*Farrea* sp.), at depths between 730 and 1119 m. Observed on video footage collected on Murray Seamount as deep as 1376 m.

Photos A) Preserved (in ethanol) branches of a *Paragorgia* sp. B colony (USNM 1075759) collected on Pratt Seamount at a depth of 1067 m. B) The back side of the same colony in photo A. C) A large preserved (in ethanol) branch complex of a *Paragorgia* sp. B colony (USNM 1075750) collected on Welker Seamount at a depth of 783 m. D) The back side of the same colony in photo C. E) A *Paragorgia* sp. B colony (USNM 1075759) just prior to collection. F) A close-up view of the same colony in photo E. A small actiniarian is attached to the colony. G) The back side of a *Paragorgia* sp. B colony (USNM 1075750) prior to collection. H) A close-up view of a *Paragorgia* sp. B colony (USNM 1075760), showing the detail of the polyps. A single zoantharian (*Zibrowius* cf. *ammophilus*) is attached to the colony (center, top). The distance between the red laser marks in photos E and G is 10 cm.

6. *Paragorgia* sp. B (continued)


A
3 cm
B
3 cm
C
3 cm
D
2 cm
E
F
3 cm
G
H

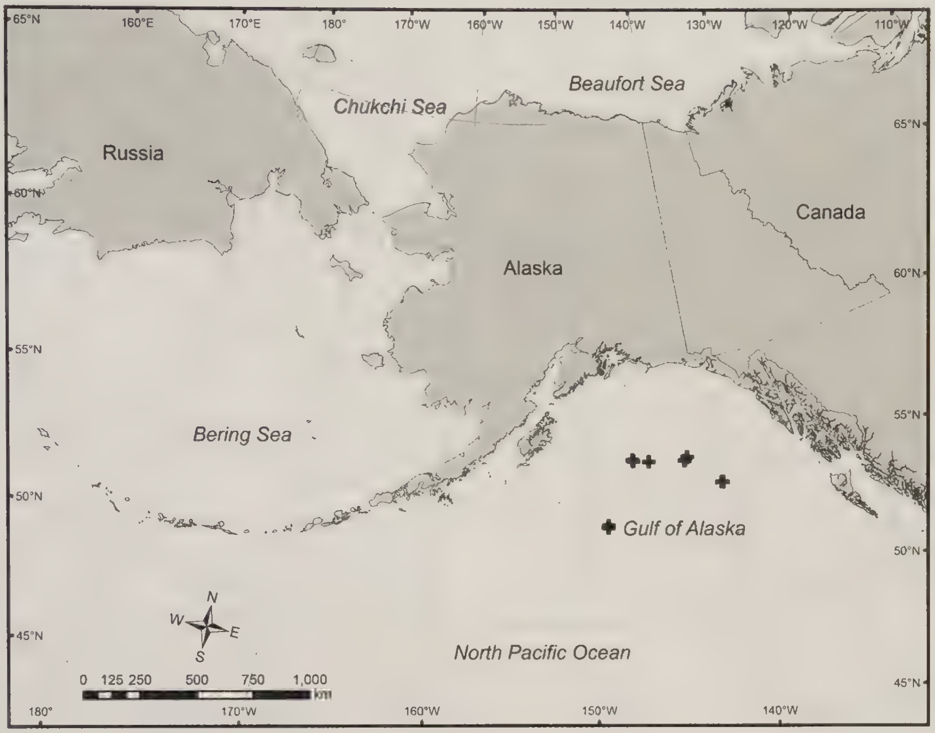

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
65°N
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 11-8

A map of the North Pacific Ocean showing the distribution of *Paragorgia* sp. B (+) in Alaska waters.

7. *Sibogagorgia cauliflora* Herrera et al., 2010

Description (Adapted from Herrera et al., 2010) Colonies are attached to substrate with a strong, prominent holdfast. Branches are stout but rubbery, more so than all *Paragorgia* species except maybe *Paragorgia* sp. B, and emanate immediately above the holdfast. Branching is irregular in a single plane. Colonies are large, up to 150 cm in height and 130 cm in width; the Alaska specimen is about 50 cm in height and 52 cm in width. Main branches are only slightly thicker than clavate terminal branches. Autozooids are irregularly located throughout the branches whereas the tiny granular siphonozooids are located uniformly on all branches. Sclerite morphology and ornamentation is included in the original description (Herrera et al., 2010).

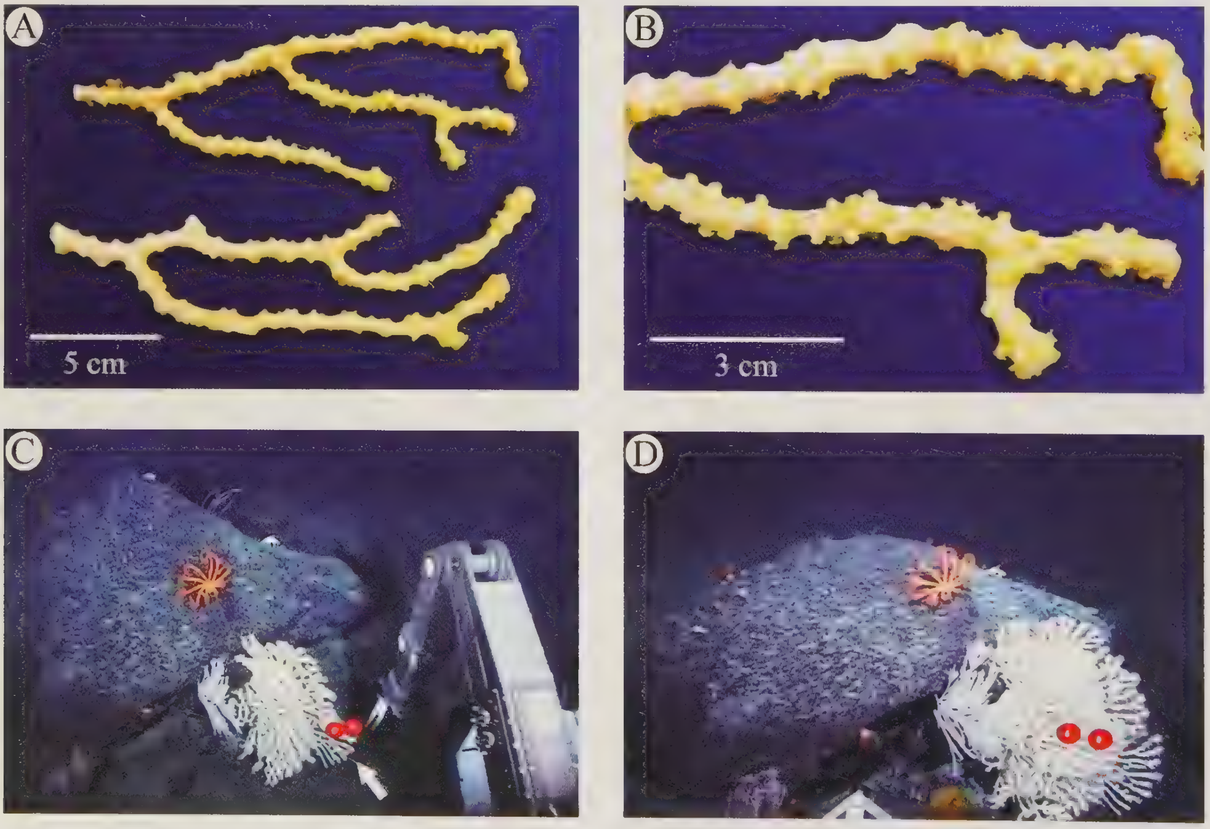
Color is creamy white to light yellow in situ and light yellowish-orange in freshly collected and ethanol preserved specimens; described as beige to red elsewhere.

Remarks *Sibogagorgia* are very similar to *Paragorgia* in almost all aspects except the noticeable lack of polyp sclerites and the presence of boundary canals rather than only a few larger canals separating the cortex of the branches from the medulla (Herrera et al., 2010).

Distribution Rare. In Alaska – known from only one collected specimen and another observed on video footage immediately adjacent to the collected specimen (see photos C and D) on Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 11-9). Elsewhere – known from Davidson Seamount off northern California and the Straits of Florida north of Cuba.

Habitat In Alaska – grows on large, angular boulders at a depth of 2766 m. Found in close association with the octocorals *Parastenella gymnogaster* and *Narella arbuscula* (see photos C and D). Elsewhere – grows singly on boulders at depths between 1698 and 3042 m.

Photos A) Preserved (in ethanol) branches of a *S. cauliflora* colony (USNM 1081143) collected on Derickson Seamount at a depth of 2766 m. B) A close-up view of the same specimen in photo A. C) Two *S. cauliflora* colonies growing together on a large boulder on Derickson Seamount at a depth of 2766 m. The white arrow points to the collected specimen (USNM 1081143). D) A close-up view of the same specimens in photo C. The distance between the red laser marks in photos C and D is 10 cm.



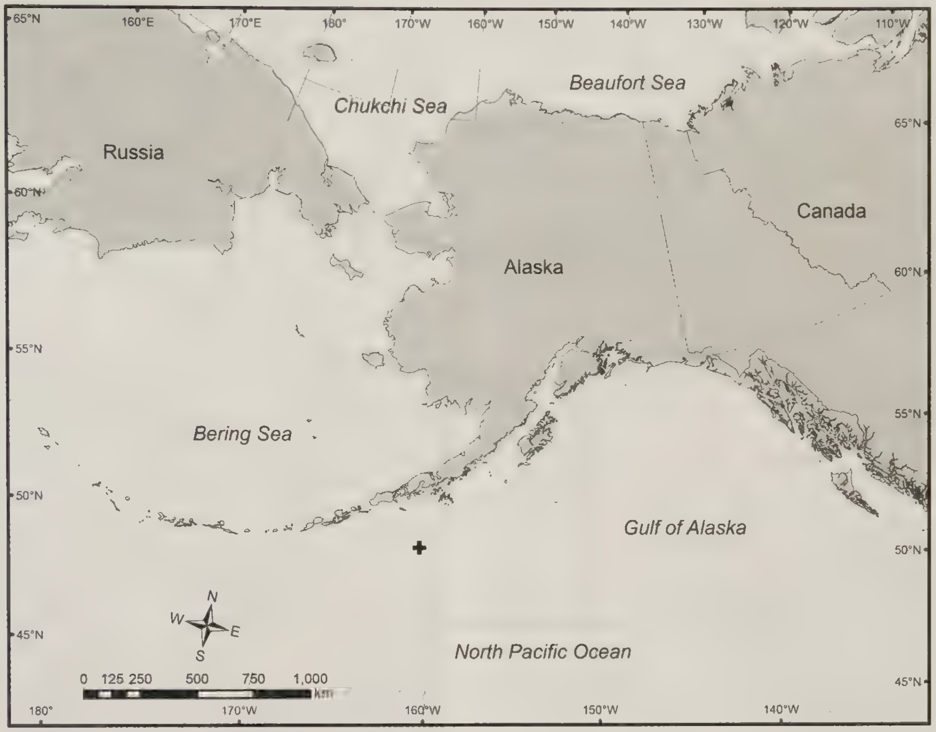

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
Canada
Alaska
60°N
55°N
Bering Sea
50°N
Gulf of Alaska
45°N
N
W
E
S
North Pacific Ocean
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W
65°N
60°N
55°N
50°N
45°N

Figure 11-9

A map of the North Pacific Ocean showing the distribution of *Sibogagorgia cauliflora* (+) in Alaska waters.

Subfamily Anthomastinae

8. *Heteropolypus japonicus* (Nutting, 1912)

Description (Adapted from Nutting, 1912) The holotype measures 6 cm in height and the capitulum is 4.1 cm in diameter. The polyps (autozooids) are relatively infrequent, large, sterile and retractile, and arranged uniformly over the capitulum including the margin. The body cavities extend directly to join the stem cavity. There are a number of minute, smooth, bar-like spicules in the polyps and also minute crosses, stars, and double stars. All spicules are smaller than usual for the genus.

Siphonozooids are fertile and densely crowded between autozooids over the entire upper surface of the capitulum. They appear as closely packed, rounded, or cone-shaped verrucae with a pit in the center. The color of the type specimen (USNM 30038) is dark red with slightly darker polyps and a slightly lighter stalk.

The largest of the two known Alaska specimens (USNM 1006252) has a perfectly round capitulum, 4.8 cm in diameter, with a relatively short but stout stalk without autozooids. The colony has a total height of about 8 cm. The large autozooids (about 28 total) are in various states of retraction and more or less uniformly situated over the capitulum including the margin. Siphonozooids are densely packed between autozooids over the entire upper surface of the capitulum (see photo C). The stalk is prominent and relatively long (approximately 60% as long as the capitulum diameter) with a large attachment point. The color of the capitulum and stalk in the dried state is a very pale pink to orange; color of the polyps is pale red.

Remarks This taxon is known in Alaska from only two specimens (USNM 1006252 and USNM 1006300) identified by F. M. Bayer in 2001. Closer examination of the specimens is warranted to determine if they are indeed *Heteropolypus japonicus* or represent an undescribed species.

The coenenchymal scales are composed principally (98.6%) of high-magnesium calcite (8.4 mol% $MgCO_3$) with small amounts of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – Tanaga Pass

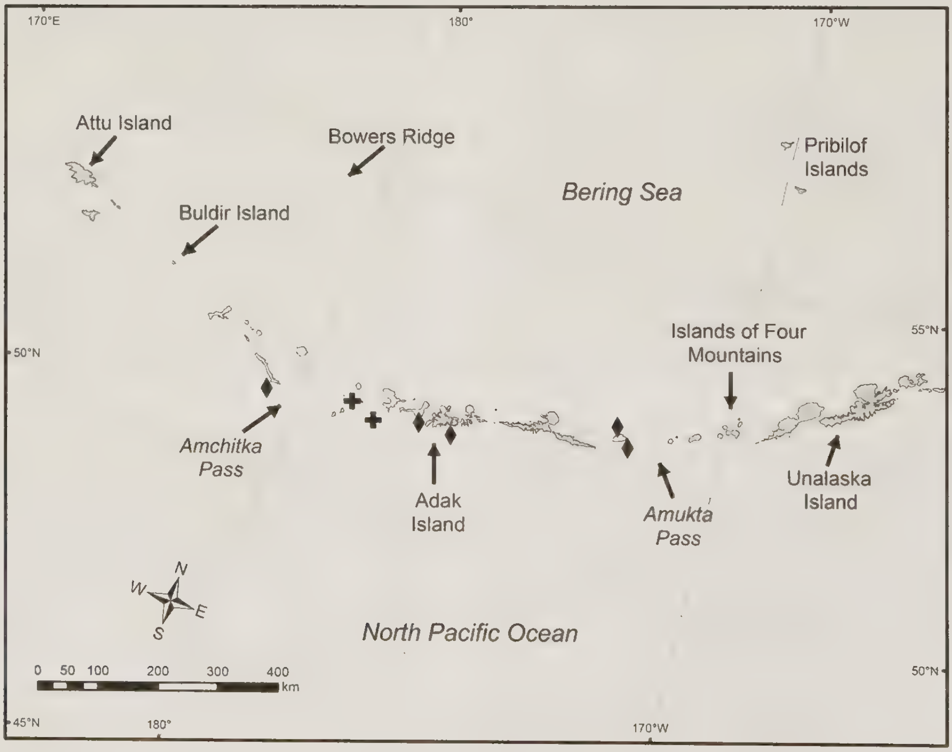


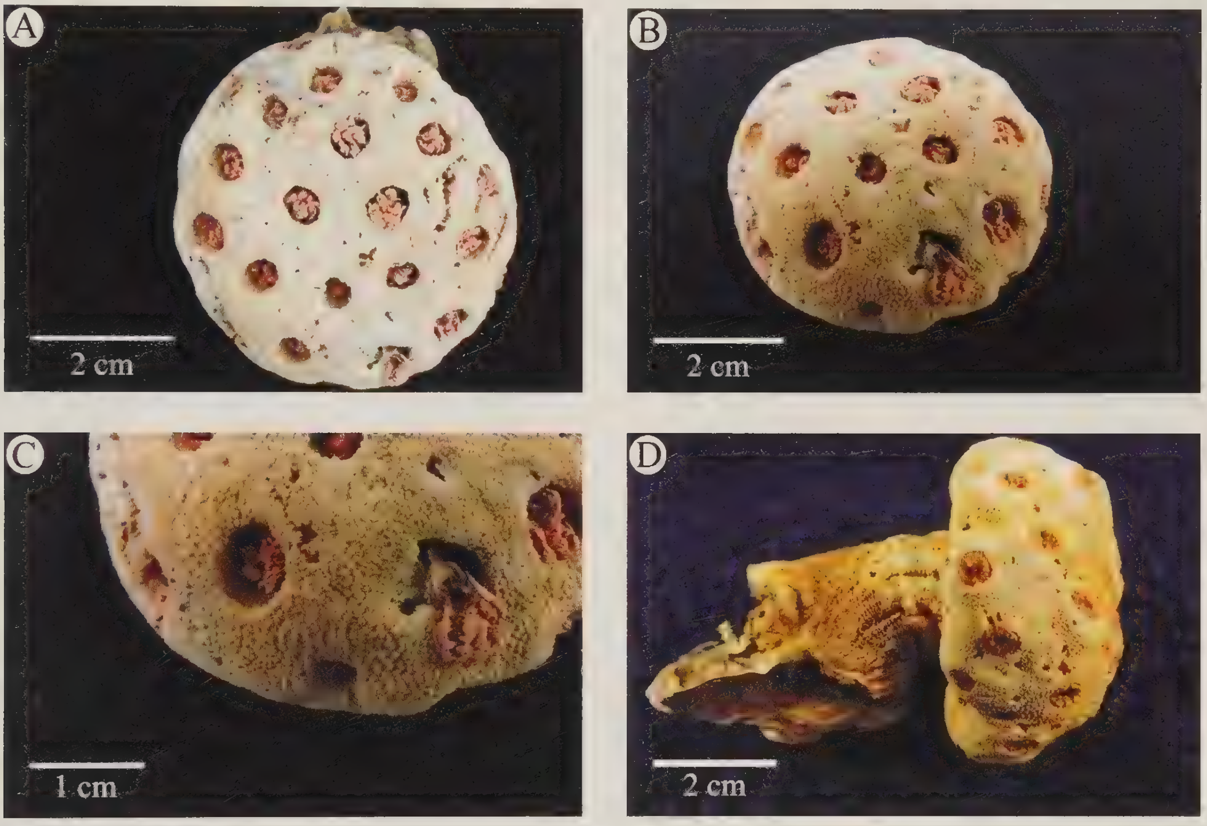
Figure 11-10

A map of the Aleutian Islands showing the distribution of *Heteropolypus japonicus* (**+**) and *Heteropolypus ritteri* (♦) in Alaska waters.

and Delarof Islands, central Aleutian Islands (Fig. 11-10). Elsewhere – *H. japonicus* is documented from Japan, southwest of Hokkaido and south and east of Honshu. The type specimen (USNM 30038) is from a depth of 584 m (Molodtsova, 2013).

Habitat In Alaska – likely found in scattered patches in areas of small cobbles, pebbles, sand, and shell at depths between about 400 and 424 m. Elsewhere – reported at depths between 486 and 996 m.

Photos A) A dorsal view of a dried whole *H. japonicus* colony (USNM 1006252) collected near the Delarof Islands, central Aleutian Islands, at a depth of about 400 m. B) An oblique lateral view of the same specimen in photo A. C) A close-up view of the same specimen in photo A. D) A dried whole *H. japonicus* colony (USNM 1482137) collected in Tanaga Pass, central Aleutian Islands, at a depth of 424 m. This specimen is attached to a shell, most likely that of a large thoracican barnacle.



9. *Heteropolypus ritteri* (Nutting, 1909)

Description (Adapted from Nutting, 1909) Colonies have a round, expanded disk-shaped holdfast, with a sterile, relatively short and stout stalk, and a somewhat flattened mushroom-shaped capitulum. The capitulum is up to 10 cm in diameter. Autozooids are sparse and irregularly positioned over the entire capitulum. Polyps are completely retractile but the verrucae do not close over the retracted polyps, leaving a sunken pit 6 mm in diameter. Siphonozooids are densely crowded between the autozooids over the entire upper surface of the capitulum, giving it a granular appearance.

Sclerites include abundant needle-like forms embedded in the surface of the capitulum, abundant stars and double stars embedded on the surface of the capitulum between the siphonozooids, and star-like forms densely packed in the polyp walls. Tufts of needle-like sclerites surround the autozooids.

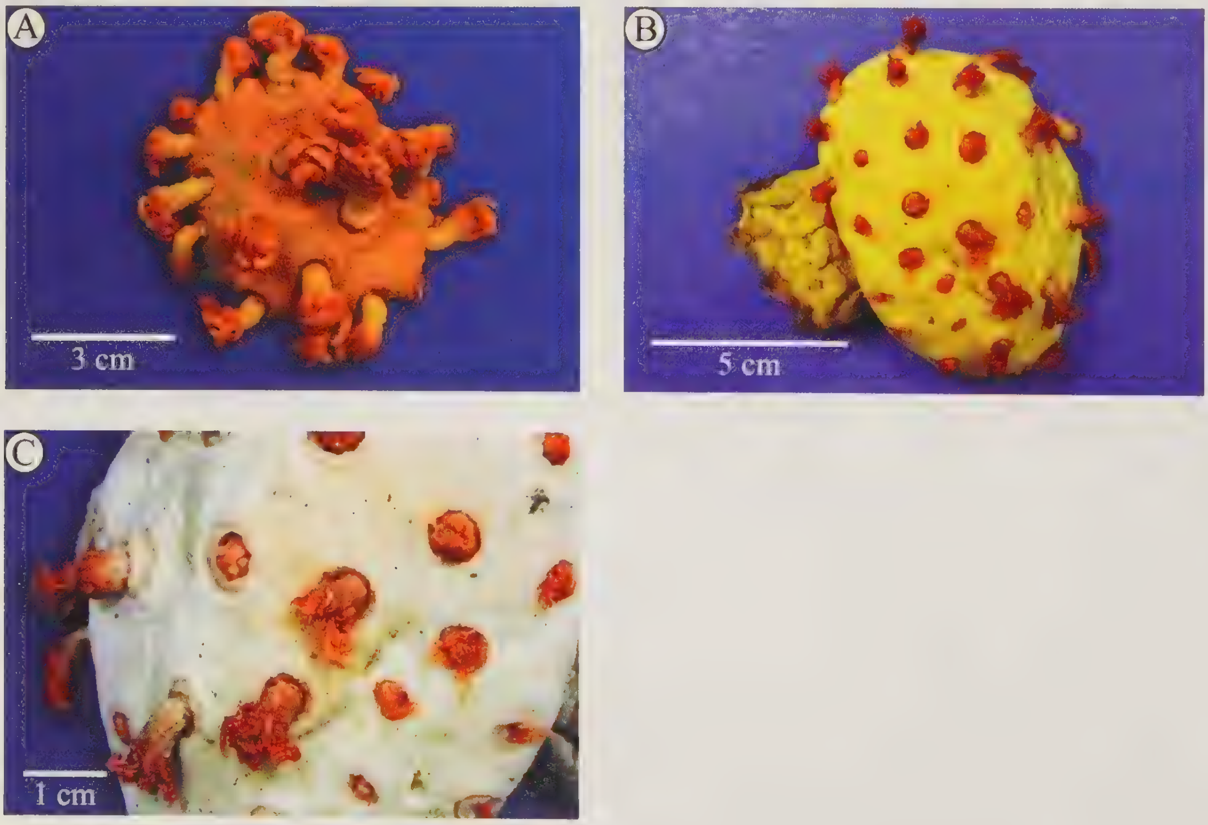
The polyps are generally a deep crimson-red with lighter stalks; the color of the capitulum and stalk is variable and typically the same color (red or pink to creamy white).

Remarks The reproductive biology, larval dynamics including recruitment, and growth rate of this species have been studied in the laboratory (Cordes et al., 2001).

Distribution Common. In Alaska – Aleutian Islands from Amukta Pass to south of Amchitka Island (Fig. 11-10). Elsewhere – along the west coast of North America from British Columbia (west of the Queen Charlotte Islands) to off San Diego including several seamounts off California. The type specimen (USNM 25422) was collected off California at a depth of 801 m (Molodtsova, 2013).

Habitat In Alaska – likely found singly or in scattered patches in areas of small cobbles, pebbles, and sand at depths between 241 and 429 m. Elsewhere – reported in rocky areas at depths between 55 and 1646 m.

Photos A) A preserved (in ethanol) whole *Heteropolypus ritteri* colony (USNM 43179) collected near the Queen Charlotte Islands, northern British Columbia, at a depth of 373 m. B) A preserved (in ethanol) whole *H. ritteri* colony (USNM 43466) collected south of Monterey Bay, California, at a depth of 640 m. C) A close-up view of the same specimen in photo B.



10. *Heteropolypus* sp.

Description (Adapted from Molodtsova, 2013) Colonies are mushroom-shaped to obconic and distinctly separated into a capitulum and sterile stalk. Polyps are dimorphic or trimorphic and have sclerites. Autozooids are relatively scarce, large, sterile and retractile, arranged evenly over the capitulum or only at the margin. Anthocodial armature is often asymmetrically developed, with ridges of more-developed sclerites on the dorsal side of the autozooid.

Siphonozooids are fertile, numerous, strongly armored, and densely set between the autozooids (see photo B on next page). Mesozooids, when present, possess feebly developed, retractile tentacles and are scattered between the siphonozooids. Sclerites are flanged rods, radiates, clubs, rods, plates, and spindles. Pharyngeal sclerites are predominantly platelets. Tentacular sclerites are rods, clubs, spindles, multi-radiates, plates, and crosses.

The largest colonies observed in Alaska may be 30 cm in height and 45 cm in diameter (with fully extended autozooids), possess more than 50 large autozooids, and form dense patches of more than 20 colonies/m^2. Colonies exhibit a broad range of colors in life including the full range of red and pink, orange, and creamy white. Stalks, autozooids, and polyps may be the same or different color as the capitulum.

Remarks This group includes 72 collected specimens (and many observations from video footage) identified only to genus and represents an ideal collection of specimens to undertake a much needed reexamination of the genus in the North Pacific Ocean. The collection undoubtedly includes specimens of *H. japonicus*, *H. ritteri*, *Pseudoanthomastus*, *Anthomastus*, and likely one or more undescribed species.

Heteropolypus spp. typically harbor few associated fauna.

Distribution Common. In Alaska – eastern Gulf of Alaska, Aleutian Islands to west of Attu Island and including Petrel Bank, the eastern Bering Sea to near St. Lawrence Island, and Pratt, Quinn, Giacomini, and Derickson Seamounts in the Gulf of Alaska Seamount Province (Fig. 11-11). This taxon is also present on Patton Seamount at depths between 393 and 3209 m (Hoff and Stevens, 2005), and examination of archived video footage (senior author, unpubl. data) confirmed the presence of the taxon on most of the seamounts that have been explored including Dickens (depth 746 m), Welker (depths 784–1885 m), Pratt (depths 912–1935 m), Quinn (depth 2316 m), Giacomini (depths 730–2730 m), Murray (depths 657–1851 m), Patton (depths 592–1754 m), Marchand (depth 2465 m), and Chirikof (depth 2778 m). Notably, there are no reports of this taxon from the western Gulf of Alaska or the Arctic region. Elsewhere – *Heteropolypus* spp. are broadly distributed throughout the Pacific, Indian, and North Atlantic Oceans (Molodtsova, 2013).

Habitat In Alaska – found singly or in scattered patches in many habitat types including areas of cobbles, pebbles, and sand and in moderate-current areas

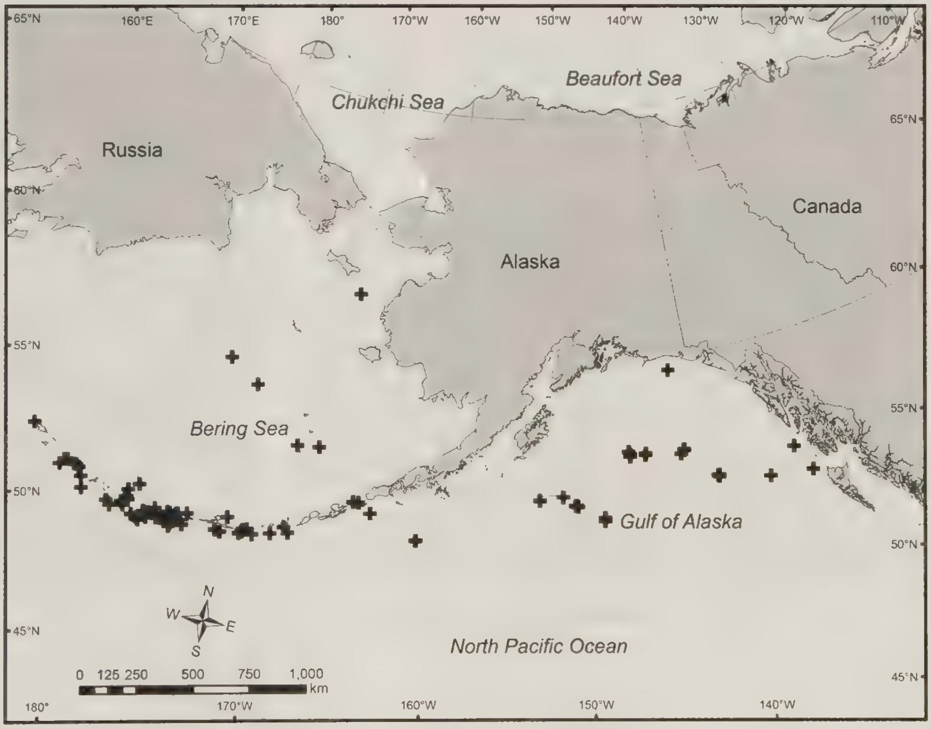


Figure 11-11

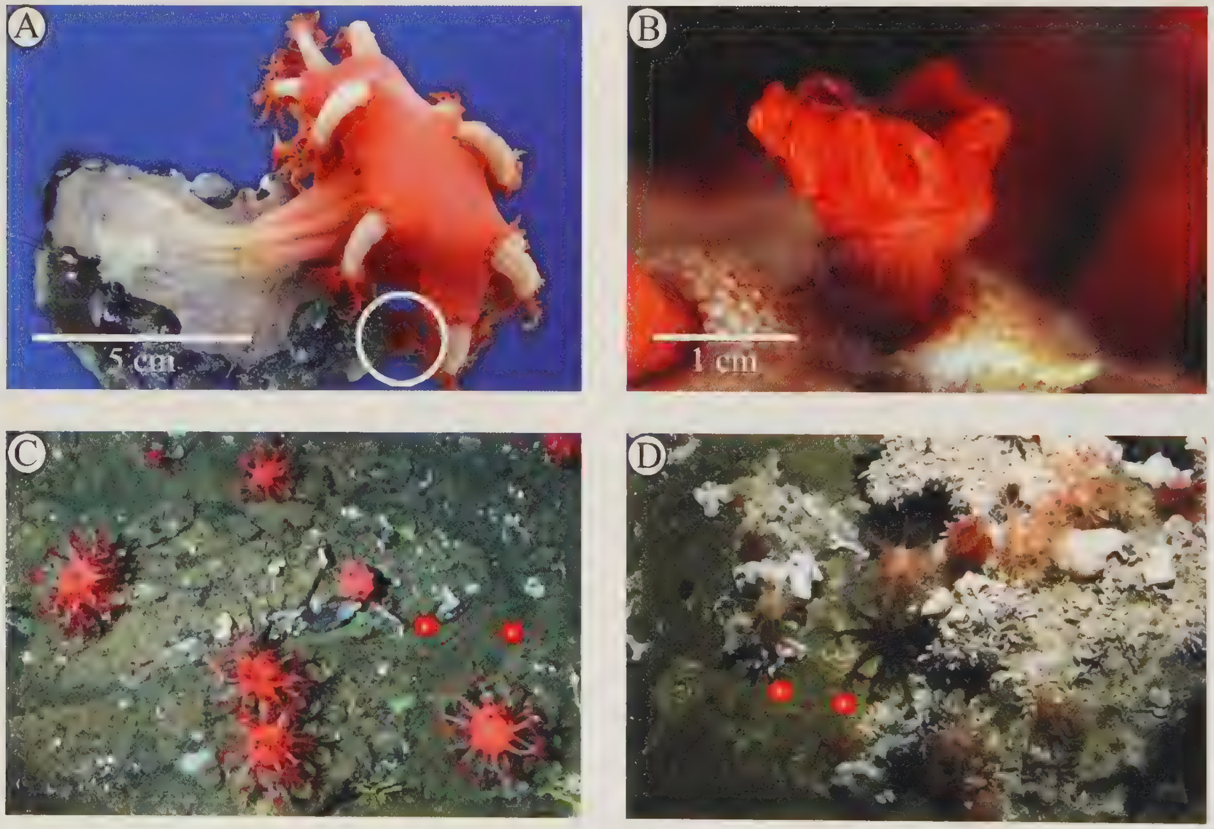
A map of the North Pacific Ocean showing the distribution of *Heteropolypus* sp. (+) in Alaska waters.

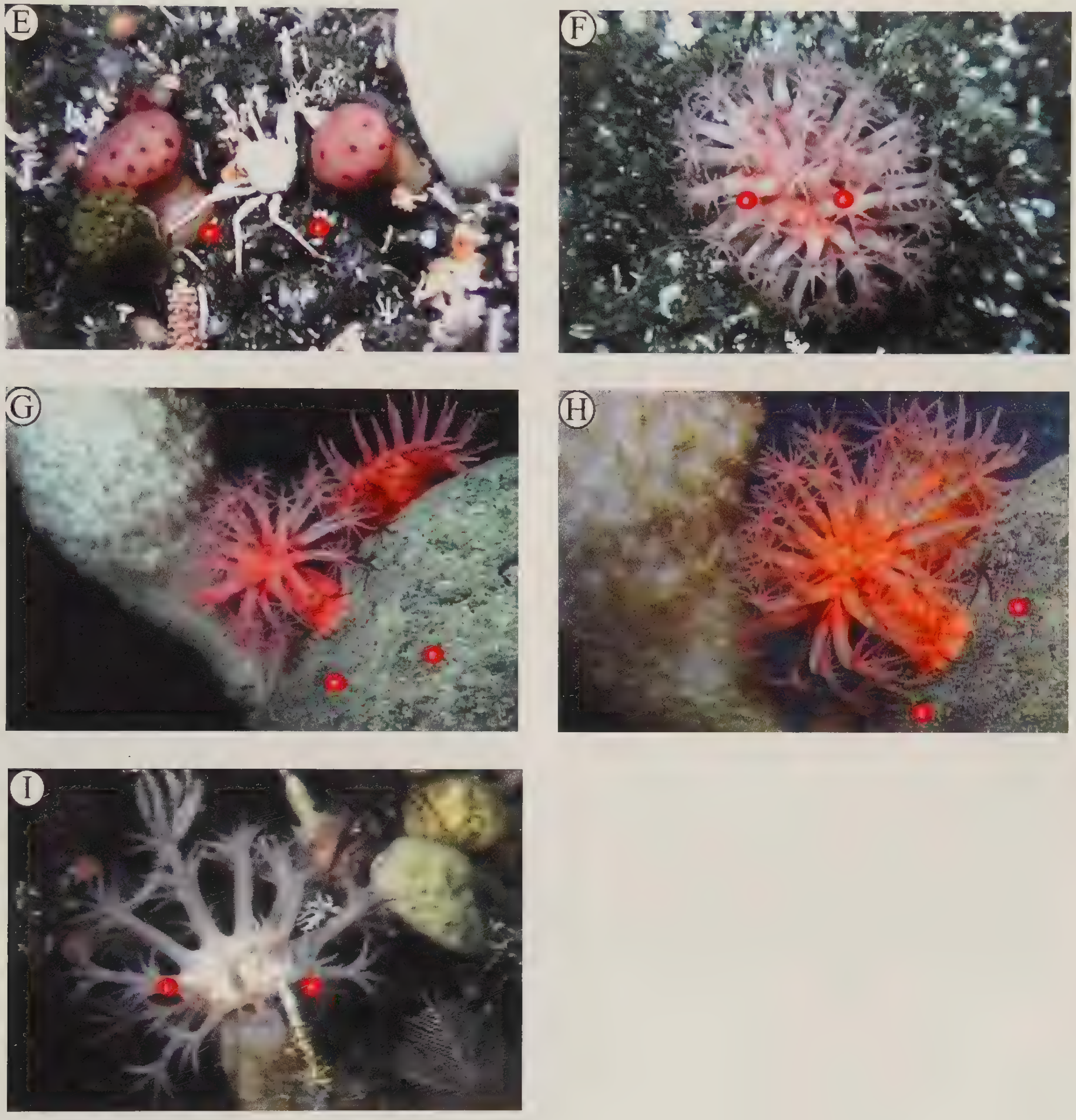
of bedrock at depths between 29 and 4216 m. Recently discovered growing on carbonate mounds on the flanks of a mud volcano in the southeastern Gulf of Alaska (see photo D; Greene[10]). Elsewhere – reported at depths between 55 and 1646 m. Examination of archived video footage (senior author, unpubl. data) confirmed the presence of the taxon on Warwick Seamount off Washington at depths between 871 and 1719 m.

Photos A) A fresh whole *Heteropolypus* sp. colony (CAS 234576) collected in Adak Canyon, central Aleutian Islands, at a depth of 1717 m. A juvenile colony is highlighted within the white circle. B) A close-up view of a *Heteropolypus* sp. specimen (USNM 1116850) collected in Zhemchug Canyon, eastern Bering Sea, at a depth of 915 m. C) A habitat heavily populated by *Heteropolypus* sp. in Adak Canyon at a depth of 1734 m. The distance between the red laser marks is 20 cm. D) *Heteropolypus* sp. recently discovered growing on a carbonate mound on a mud volcano in the southeastern Gulf of Alaska at a depth of 1000 m. E) Two *Heteropolypus* sp., with polyps fully retracted, photographed on Amchixtam Chaxsxii, central Aleutian Islands, at a depth of 1254 m. A juvenile Verrill's king crab (*Paralomis verrilli*) takes refuge between the two specimens. F) A *Heteropolypus* sp. colony (J2103-4-1; CAS # pending) collected on Amchixtam Chaxsxii at a depth of 1339 m. G) A *Heteropolypus* sp. colony (USNM 1075806) photographed on Giacomini Seamount, Gulf of Alaska Seamount Province, at a depth of 2710 m. H) A close-up view of the same colony in photo G. I) A *Heteropolypus* sp. colony photographed on Amchixtam Chaxsxii at a depth of 559 m. The distance between the red laser marks in photos D–I is 10 cm.

---

[10] Greene, G. 2016. Personal commun. University of California, 1850 Research Park Dr., Ste. 300, Davis, CA 95618-6134.




E
F
G
H
I

11. *Pseudoanthomastus* sp.

Description (Adapted from Molodtsova, 2013) Colonies are mushroom-shaped and capitate with a dome-shaped capitulum sharply separated from a conspicuous stalk. Autozooids are few in number, large, and retractile (but rarely completely), and arranged evenly over the capitulum. Polyps are on very long stalks, dimorphic, and contain sclerites. Sclerites are equally developed around the autozooids. Anthocodial armature is more developed near the base of the tentacles.

Siphonozooids are fertile, usually conspicuous, feebly armored, few in number, and scattered among the large autozooids. Sclerites are principally radiates, warty clubs, and clubs with distal heads, and additionally a few tubercules, rods, spindles, and crosses. Pharyngeal sclerites are predominantly rodlets. Tentacular sclerites are needles, rods, clubs, and radiates.

Alaska specimens have between 5 and 10 very large autozooids; the largest specimen is approximately 5 cm in height and 3 cm in width at the base. The capitulum and autozooids including the polyps are uniform red to dark pink in both life and in ethanol. The stalk is a uniform lighter shade both in life and in ethanol.

Remarks *Pseudoanthomastus* is a small genus containing only seven species, of which only one, *Pseudoanthomastus fisheri* (Bayer, 1952), is known to occur in the North Pacific Ocean (in Hawaii at depths between 388 and 876 m). The four Alaska specimens should be more closely examined to determine if they are *P. fisheri* ranging northward from the Hawaiian region or an unknown species.

Pseudoanthomastus elsewhere are reported to harbor polynoid polychaetes (Watling et al., 2011).

Distribution Rare. In Alaska – known from only four specimens collected on two seamounts (Densen and Welker) in the Gulf of Alaska Seamount Province and from video observations made elsewhere on Welker Seamount (Fig. 11-12). Elsewhere – unknown.

Habitat In Alaska – always found in small clusters of 2–3 colonies in areas of basalt and fractured basalt at depths between 1122 and 1410 m, but observed in situ to a depth of 2642 m (senior author, personal observ.).

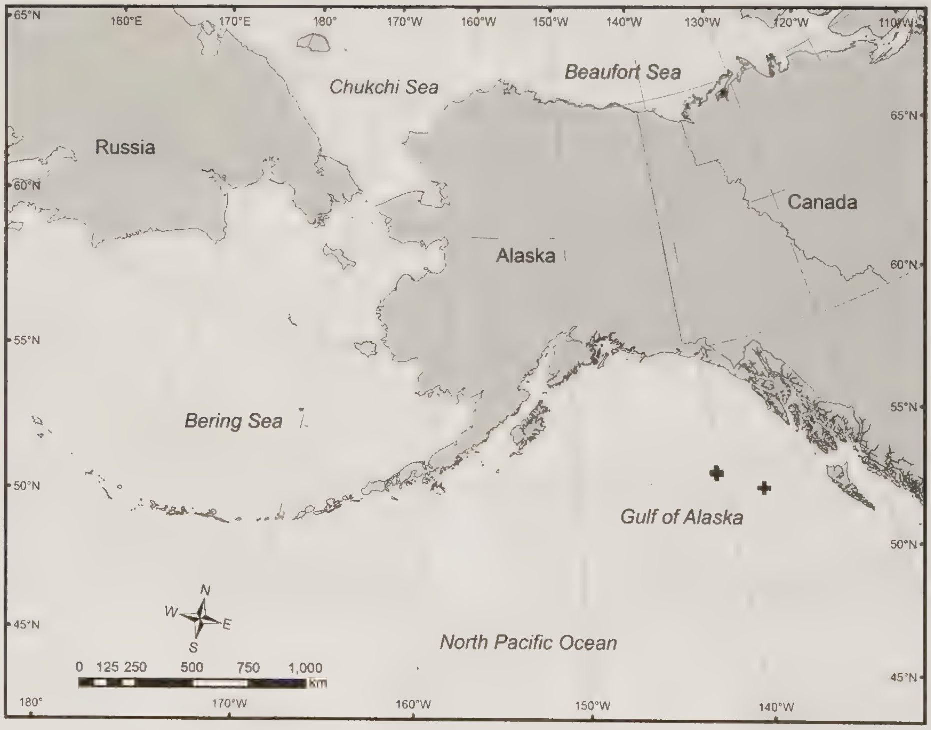
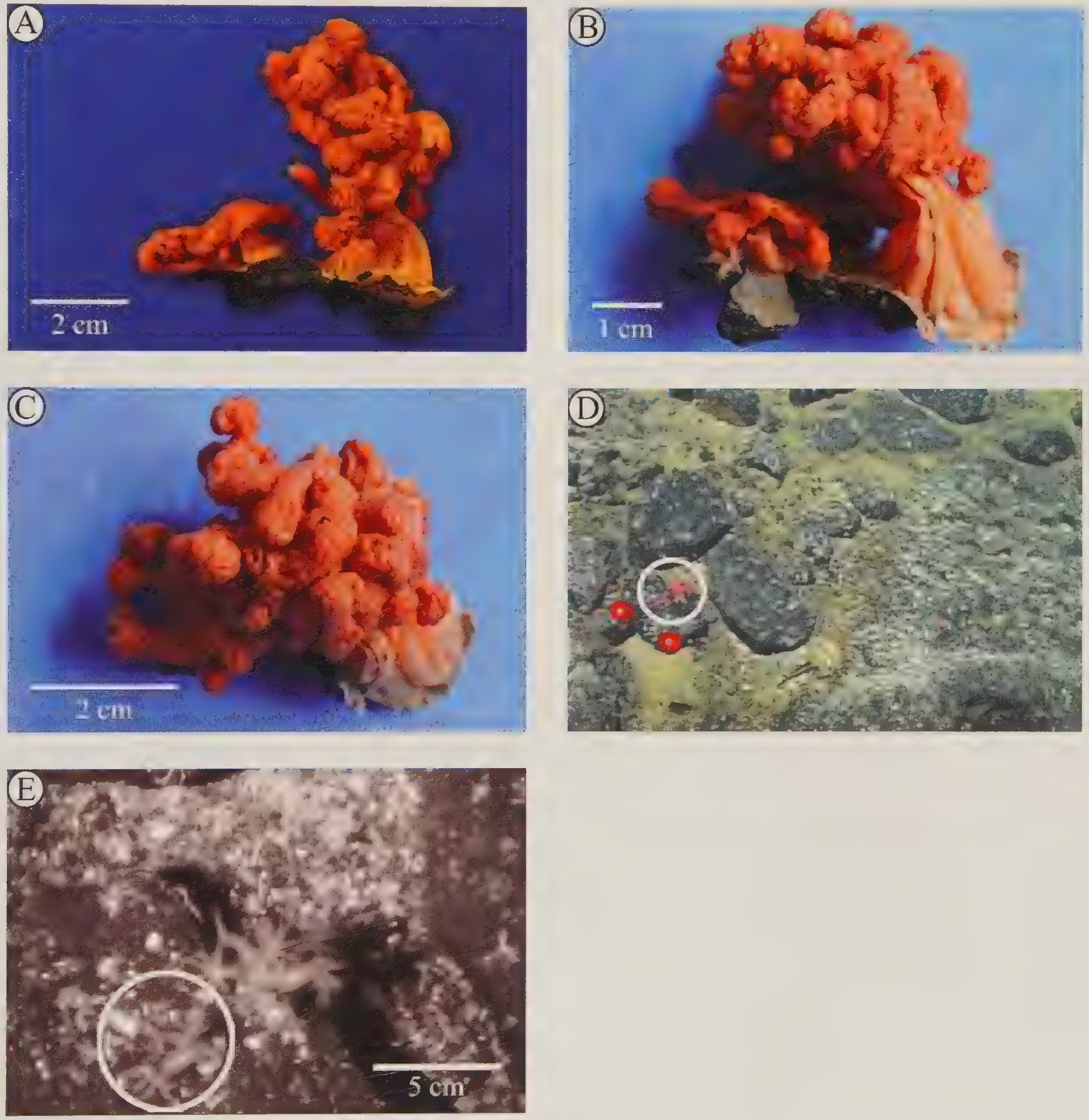


Figure 11-12

A map of the North Pacific Ocean showing the distribution of *Pseudoanthomastus* sp. (+) in Alaska waters.

Photos A) Two preserved (in ethanol) whole *Pseudoanthomastus* sp. colonies (USNM 1075803) collected on Densen Seamount in the Gulf of Alaska Seamount Province at a depth of 1410 m. The specimens are not attached at the base. B) A close-up view of the same specimens in photo A. C) The view from the top of the same specimens in photo A. D) *Pseudoanthomastus* sp. colonies (USNM 1075805; lower left, inside the white circle) collected on Welker Seamount in the Gulf of Alaska Seamount Province at a depth of 1122 m. The distance between the red laser marks is 10 cm. E) A close-up view of the same colonies in photo D (center). Note the smaller specimen to the left, inside the white circle.



CHAPTER 12

Family Keratoisididae

Of the 13 genera in the family Keratoisididae currently accepted worldwide (WoRMS Editorial Board, 2022), only four are known from Alaska waters: *Bathygorgia*, *Isidella*, *Keratoisis*, and *Orstomisis*. The family Keratoisididae was known until just recently as the family Isididae (Saucier et al., 2021). The original description of the family (Gray, 1870), amended by Verrill (1922), described corals with simple or variably branched axes consisting of long calcareous and often hollow sections that alternate with shorter horny joints consisting of pure gorgonin. Branches, if present, typically arise from the horny nodes but occasionally from the calcareous internodes. The coenenchyme is typically thin with long conspicuous sclerites and occasionally small scale-like sclerites near the surface. Calyces are large and prominent, filled with large fusiform sclerites, of which eight or more are larger than the rest and commonly project as sharp marginal spines between the bases of the tentacles, forming an armature for the protection of the tentacles that are typically not completely retractile.

A revised description for the family, based on DNA sequence data (amplification of *mtMutS* and 18S) and consequent reconstructed phylogeny, contains all four genera found in Alaska and follows from Saucier et al. (2021). Colonies have an articulated skeleton of hollow or solid calcium carbonate internodes interrupted by brown to dark brown proteinaceous and sclerite-free nodes. Colonies may be unbranched ("whip-like") or with branches originating at the nodes or internodes, and from either immediately distal to the nodes, or from mid-way along the internode. The coenenchyme is usually thin but sometimes slightly thickened and covered in a fleshy tegument containing nematocysts. Polyps are monomorphic and non-retractile but can contract to varying degrees, never within the coenenchyme, and the tentacles may only contract over the polyp oral cavity. Sclerites are needles, spindles, rods, or scales that are arranged longitudinally, transversely, or obliquely along the polyp body and in the coenenchyme. A mesenterial arrangement of one or a cluster of needle-like sclerites protrudes between the bases of the tentacles in many species; other species may not possess needles but a mesenterial arrangement of rod-like sclerites may still be present. Pharyngeal sclerites are usually present and include tuberculated or spiny rodlets, and double stars.

Corals in this family (keratoisidids) are commonly referred to as bamboo corals since their axial skeleton consists of alternating white calcareous internodes and narrower dark proteinaceous nodes that resemble bamboo. They are known from all ocean basins and are quite common throughout the North Pacific and central Indo-Pacific regions. They are common in all regions of Alaska except the Arctic (Fig. 12-1) and are quite conspicuous given their often large size and unique skeleton. They are abundant in some regions, particularly on seamounts in the Gulf of Alaska Seamount Province (Fig. 12-1), and provide important fisheries habitat in some regions (Stone, 2014). They are deep-water fauna in Alaska, with few records shallower than 400 m, and found at depths to 4784 m. The status of the taxonomy of bamboo corals in Alaska is poor and is largely unresolved for most of the taxa we list here. Archived specimens of all taxa are available for study with several new species descriptions currently in preparation (Watling[11]); however, all bamboo coral specimens encountered, except the distinctive *Isidella tentaculum,* should be properly preserved and retained for taxonomic study.

Five morphological characteristics have traditionally been used to classify and identify bamboo corals (Bayer and Stefani, 1987): 1) colony branching, 2) sclerite morphology and arrangement, 3) degree of polyp retractability, 4) structure of the axial skeleton, and 5) the presence of an operculum on the polyps. Branching pattern, particularly with respect to origin at the nodes (*Isidella*) or internodes (*Keratoisis*), has traditionally been used as an obvious characteristic to differentiate between the genera of the Keratoisididae (Bayer, 1990; France, 2007). Undoubtedly, that character has been largely used by experts to identify many of the museum specimens from Alaska. Recent mitochondrial DNA genetics analysis has indicated that branching pattern is not a reliable character to distinguish among genera (France, 2007; Dueñas et al., 2014). Because genetic analyses and microscopic examination of sclerites (another diagnostic characteristic) have not yet been undertaken for most of the Alaska specimens, we have retained use of branching pattern with other gross colony characteristics and ecology to partition unknown specimens (and observations) generically for the purposes of this guide. These generic listings serve as placeholders to guide future collections, highlight taxa for taxonomic study using both morphological and genetics analyses, and additionally provide an updated, albeit unconfirmed, species count for the region.

---

[11] Watling, L. 2021. Personal commun. School of Life Sciences, University of Hawai'i at Mānoa, Honolulu, HI 96822.

Bathygorgia is represented by two species in Alaska: *B. profunda* and *Bathygorgia* sp. A. Colonies are often unbranched or with only a few branches; the sclerites of the polyps and coenenchyme are bar-like forms with turgid-rounded ends and are often bi-clavate. *Bathygorgia* is quite similar to *Keratoisis* but differs in the complement and shape of the sclerites (Lapointe and Watling, 2015). *Isidella* is planar, often perfectly flabellate colonies with dichotomous branching from the nodes (Kükenthal, 1919; Bayer, 1990), and is represented by three species in Alaska: *Isidella tentaculum* and two unknown species (*Isidella* sp. A and *Isidella* sp. B) from very deep water on Derickson Seamount. Alaska specimens that branch at the internodes have been designated to date as *Keratoisis*. This might be a taxonomic simplification and not necessarily accurate, but without detailed examination of sclerites and genetics analysis, this is the only characteristic to distinguish them from *Isidella* (specimens branching at the nodes).

There are currently 22 accepted species of *Keratoisis* worldwide (WoRMS Editorial Board, 2022); only one is reported from Alaska waters. Two large, whip-like specimens (USNM 75055) with a few branches at the nodes were collected in the eastern Gulf of Alaska in 1942 and identified as *Keratoisis paucispinosa* Wright and Studer, 1889 by E. Deichmann but unfortunately the record contains no specific location or depth information. *Keratoisis paucispinosa* is known from near Hawaii and Japan at depths between 347 and 539 m so the identification may be a valid range extension to the north, but the original description of *K. paucispinosa* (Wright and Studer, 1889) details an unbranched coral so it is likely that the Alaska specimens were really *Bathygorgia*.

Four additional species of *Keratoisis* have been reported from the North Pacific Ocean: *K. flabellum* Nutting, 1908 (Hawaii, 347–417 m depth), *K. japonica* Studer, 1878 (near Japan, 549 m depth), *K. philippinensis* Wright and Studer, 1889 (Sea of Okhotsk, Russia, 805 m), and *K. squarrosa* Kükenthal, 1915 (Kükenthal, 1915a) (near Japan, depth unknown). Among the seven *Keratoisis* taxa we list here from Alaska, only *Keratoisis* sp. F is found within the same depth zone as any of these species and should be carefully compared to those congeners. Until that time, we list the Alaska *Keratoisis* generically as distinct taxa that conform to the general description of the genus but differ from each other in morphology and/or ecology.

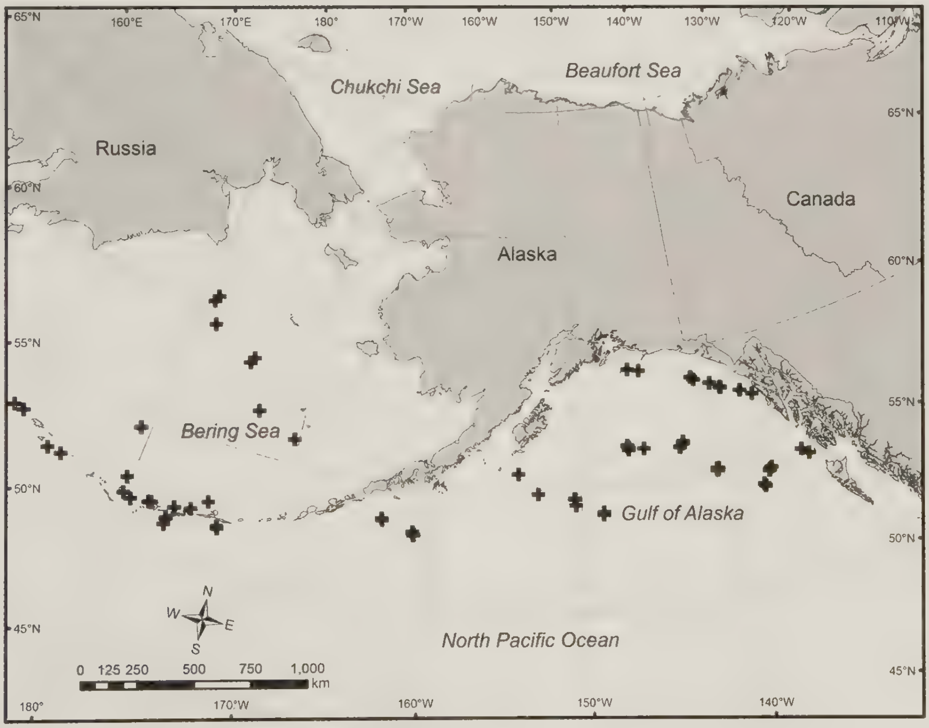


Figure 12-1

A map of the North Pacific Ocean showing the distribution of corals in the family Keratoisididae (+) in Alaska waters.

1. *Bathygorgia profunda* Wright, 1885

Description The type specimen was reportedly only a fragment of the axis measuring 6 cm in length and 1 cm in diameter (3 cm in diameter including preserved polyps) and consisted of three calcareous internodes and two very small horny nodes. The calcareous internodes were glassy, solid, smooth, bent or curved inward, slightly quadrangular in section but more circular distally. The coenenchyme was thin and densely covered with oblong, warty sclerites that were denser near the base of the polyps. The polyps were large (5 mm in height and 2.5 mm in diameter) and projected at right angles from the axis. Non-retractile tentacles were folded over each other in a somewhat irregular manner. Large clavate, spinulate sclerites covered the body wall of the polyp; and small, oblong sclerites densely covered the outer portions of the tentacles.

Subsequent descriptions by Wright and Studer (1889) and Nutting (1912) indicated that the axis had long, irregularly curved, and somewhat square calcareous internodes and small horny nodal joints. The coenenchyme was thin and covered with oblong warty sclerites. The polyps were large and uniserial, club-shaped (larger at the base and top than in the middle), with non-retractile tentacles; and the polyp body wall was composed of large, spiny, clavate and bi-clavate sclerites. Sclerites did not protrude beyond the tentacles.

The Alaska specimen (USNM 30076) is also only a fragment of the axis measuring 10 cm in length with a mean diameter of approximately 2.5 mm. It has one very small side branch with two polyps that measures 1.3 cm in length and is very thin and delicate. There is no evidence of additional branches. The polyps are around the whole axis branch but sparsely populated and with prominent stalks. The color of the coenenchyme in ethanol is light orange.

In addition to the type specimen and Alaska specimen (USNM 30076), nine specimens have been collected in Alaska that conform well to the above descriptions and we designate them as *B.* cf. *profunda*. Since the above descriptions were based on fragments of colonies, only these additional specimens along with the accompanying in situ observations provide detailed information on colony morphology and ecology. Colonies can be quite large (up to 230 cm in length) and occasionally bent, twisted, and with a full spiral distally in larger individuals. Colonies are mostly whiplike or monopodial but occasionally may bear as many as 10 branches that emanate from either the nodes or internodes. Branched colonies tend to be more prevalent at the shallower part of their depth range. The lower 10–25% of the stalk is naked (without polyps) and colonies are supported by a prominent but relatively small, white and reflective, mostly discoid holdfast. The coenenchyme is relatively thin; the brown nodes are of variable length and can often be seen through the tissue. Polyps are large, on all sides of the branches but predominantly on two sides, randomly arranged, and relatively sparse.

Our examination of several *B.* cf. *profunda* specimens (USNM 30076, 1081184, and 1081187) indicates that the polyps are somewhat squat between 3.6 and 5.0 mm in height and 2.5 mm in diameter. The body wall sclerites are large (0.53–1.05 mm in length by 0.10–0.23 mm in diameter), smooth, opaque, white, blunt-tipped rods. There are also smaller (0.30–0.70 mm in length by 0.04–0.08 mm in diameter), opaque body wall rods that may be a developing stage of the larger rods or fully grown but smaller body wall sclerites. Tentacular sclerites are platelets (0.11–0.19 mm in length by 0.03–0.05 mm in diameter).

Remarks Originally described as *B. profunda* by Wright (1885), this is the type species for the genus that was later synonymized with *Keratoisis* (Kükenthal, 1919). With the discovery of two new species of bamboo corals from seamounts off Tasmania, the genus *Bathygorgia* was resurrected with this species retained as the type species (Lapointe and Watling, 2015). *Bathygorgia* differs from *Keratoisis* in the complement and shape of the sclerites (Wright and Studer, 1889; Lapointe and Watling, 2015).

Both *B. abyssicola* Lapointe and Watling, 2015 and *B. tasmaniensis* Lapointe and Watling, 2015, the only other species in the genus, are unbranched. There are no known in situ images of *B. profunda* and little evidence from the two known specimens to indicate that it is branched, aside from the small auxiliary branch on the Alaska specimen.

Colonies on seamounts occasionally host ophiuroids and the chirostylid crab, *Sternostylus iaspis*, and attached skeletons are used by crinoids and brisingid sea stars as platforms for suspension feeding.

Distribution Apparently common (Fig. 12-2). In Alaska – specimens have been collected in the Gulf of Alaska Seamount Province (Giacomini, Pratt, Patton, and Derickson Seamounts) and the eastern Aleutian Islands (south of Davidson Bank) to the central Aleutian Islands (north of Atka Island) on the island arc slope along the eastern Bering Sea. Additionally, video observations have been made on Dickens, Densen, Welker, Pratt, and Murray Seamounts and south of Amlia Island in the central Aleutian Islands (senior author, personal observ.). Elsewhere – the only other known specimen, the type specimen, was collected at *Challenger*

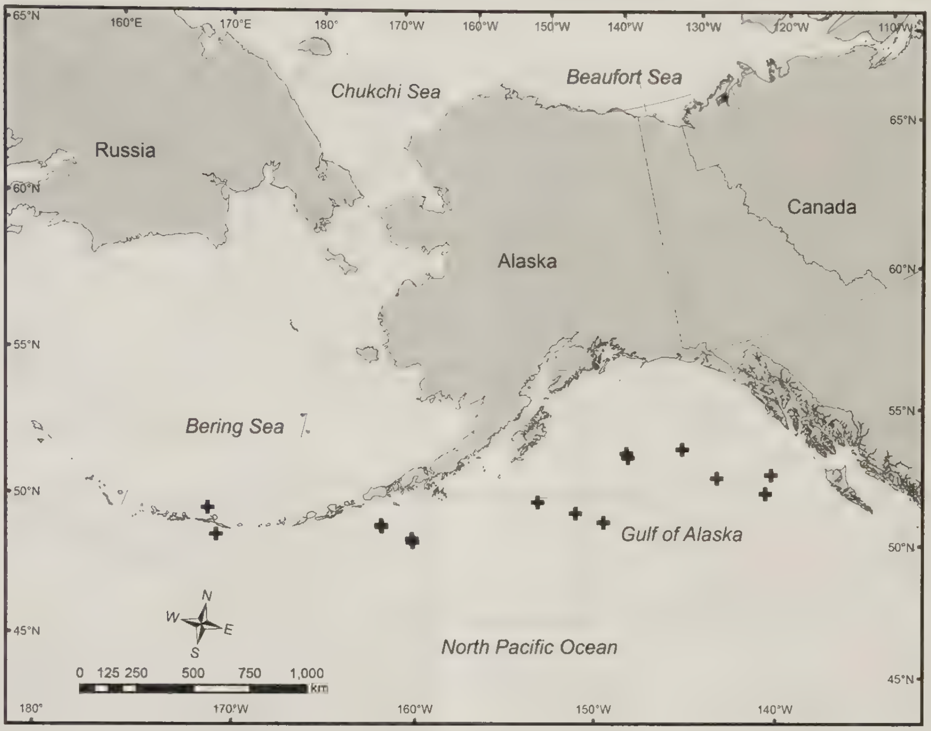

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 12-2

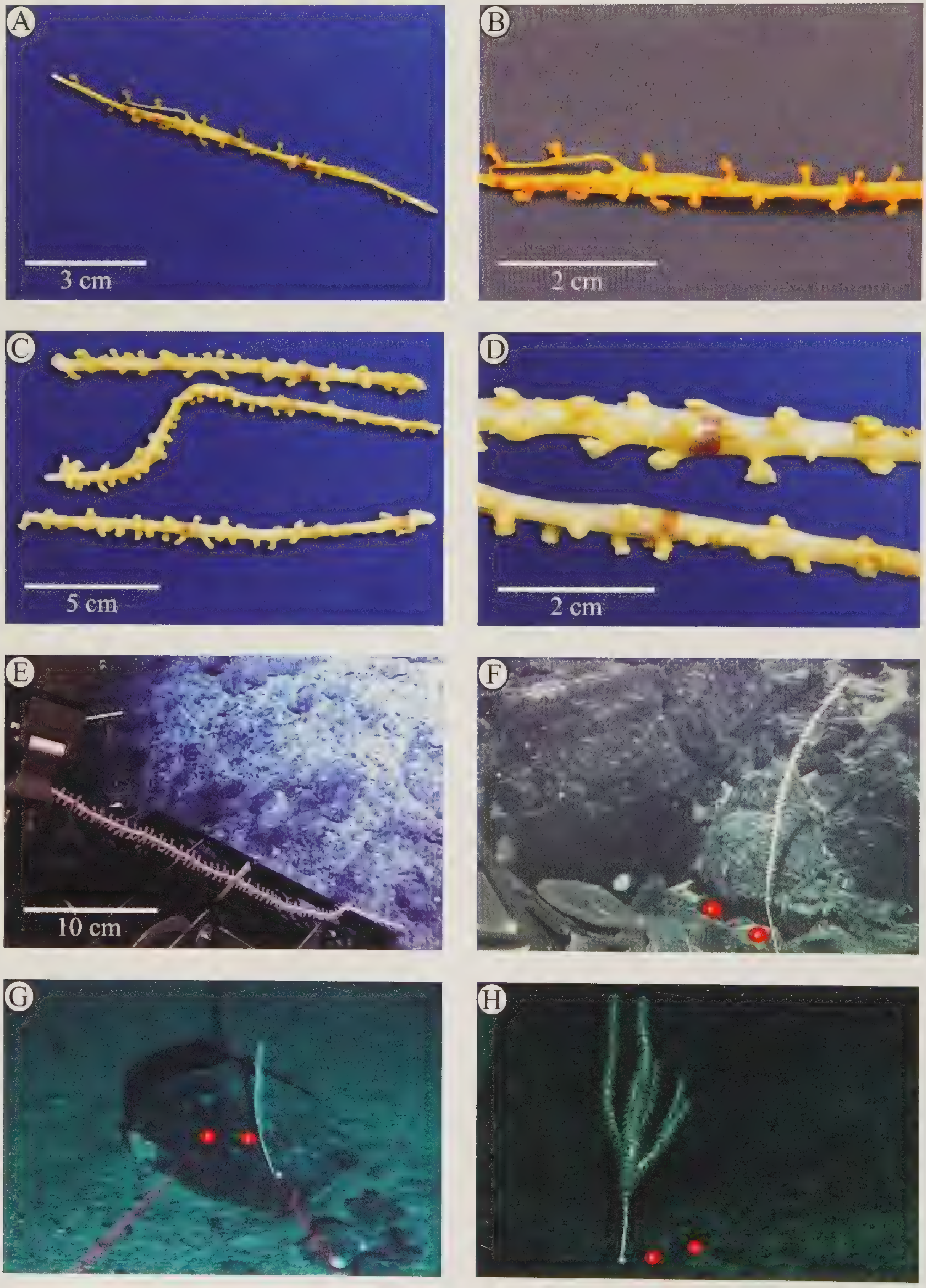
A map of the North Pacific Ocean showing the distribution of *Bathygorgia profunda* (+) in Alaska waters.

station 241 in the central Pacific Ocean between Japan and Hawaii.

Habitat In Alaska – grows on hard substrate including bedrock vertical walls, fractured bedrock, pillow lavas, conglomerate, siltstone, boulders, and cobbles in deep water (2372–4784 m). This is one of the deepest known records for the family. Elsewhere – attaches to hard rock in areas of soft sediment (red clay) at a depth of 4206 m.

Photos A) A fragment of a preserved (in ethanol) *B. profunda* colony (USNM 30076) collected north of Atka Island in the central Aleutian Islands at a depth of 3230 m. B) A close-up view of the same specimen in photo A. C) A large portion of a preserved (in ethanol) *B.* cf. *profunda* colony (USNM 1081184) collected on Derickson Seamount at a depth of 4784 m. D) A close-up view of the same specimen in photo C. E) The same colony in photo C during collection. F) A *B.* cf. *profunda* colony photographed on Welker Seamount at a depth of 2778 m. G) A *B.* cf. *profunda* colony photographed on Densen Seamount at a depth of 2488 m. H) A multibranched *B.* cf. *profunda* colony photographed on Giacomini Seamount at a depth of 2484 m. The distance between the red laser marks in photos F–H is 10 cm.

1. *Bathygorgia profunda* Wright, 1885 (continued)


A
3 cm
B
2 cm
C
5 cm
D
2 cm
E
10 cm
F
G
H

2. *Bathygorgia* sp. A

Description Colonies are whip-like, infrequently branched, never with more than four side branches that originate from the internodes, and up to 127 cm in length. Whip-like colonies are often curved or spiraled, especially distally, sometimes with two complete spirals and more often in a clockwise direction. The axis is quite flexible but strong and difficult to break. Internodes are variable in length (3.1–5.1 cm); the first node is often immediately above the holdfast. Nodes are relatively small (approximately 2–3 mm in length), somewhat recessed from the internodes, and black in color. Holdfasts are relatively small, cup-shaped, typically without coenenchyme, and strongly attached to the substrate. Polyps are large (8 mm in length), densely populated on all branch surfaces and the axis to the holdfast, and characteristically with a bright red mouth. Tentacles are relatively short (1.5 mm) with lighter-colored tips. Polyps retract very quickly when colonies are disturbed during collection. The coenenchyme is relatively thin; the nodes are visible in fresh specimens. The color of the coenenchyme in life and in ethanol is a uniform light orange.

Our critical examination of several specimens (USNM 1082131, 1082132, 1082133, and 1082146) indicates that the polyps are larger (up to 5.5 mm in length) and more slender (>2.5 mm in diameter) than those in *B.* cf. *profunda*. The body wall of each polyp has eight very long (1.80–3.50 mm in length) and slender (0.05–0.15 mm in diameter) rods that protrude beyond the tentacles. The rods are smooth, slightly curved, and opaque. The body wall sclerites proximal to the larger ones are smaller (0.07–1.00 mm in length by 0.05 mm in diameter). Tentacular sclerites are platelets (0.18–0.23 mm in length by 0.02–0.05 mm in diameter).

Remarks This species is represented by five specimens and more than 120 video observations. Colonies occur in the same geographical areas as *B.* cf. *profunda* but occupy shallower water areas that do not appear to overlap with each other. Based on our examination of sclerites, this species is clearly different from *B.* cf. *profunda*. Additionally, the polyps are larger, more slender, and situated equally on all sides of the branch axis. Colonies have little or no naked section of the axis basally, have a greater tendency to curve or spiral distally, and have much less tendency to branch. Due to these differences we tentatively list this taxon as a separate species until genetic analyses can be undertaken.

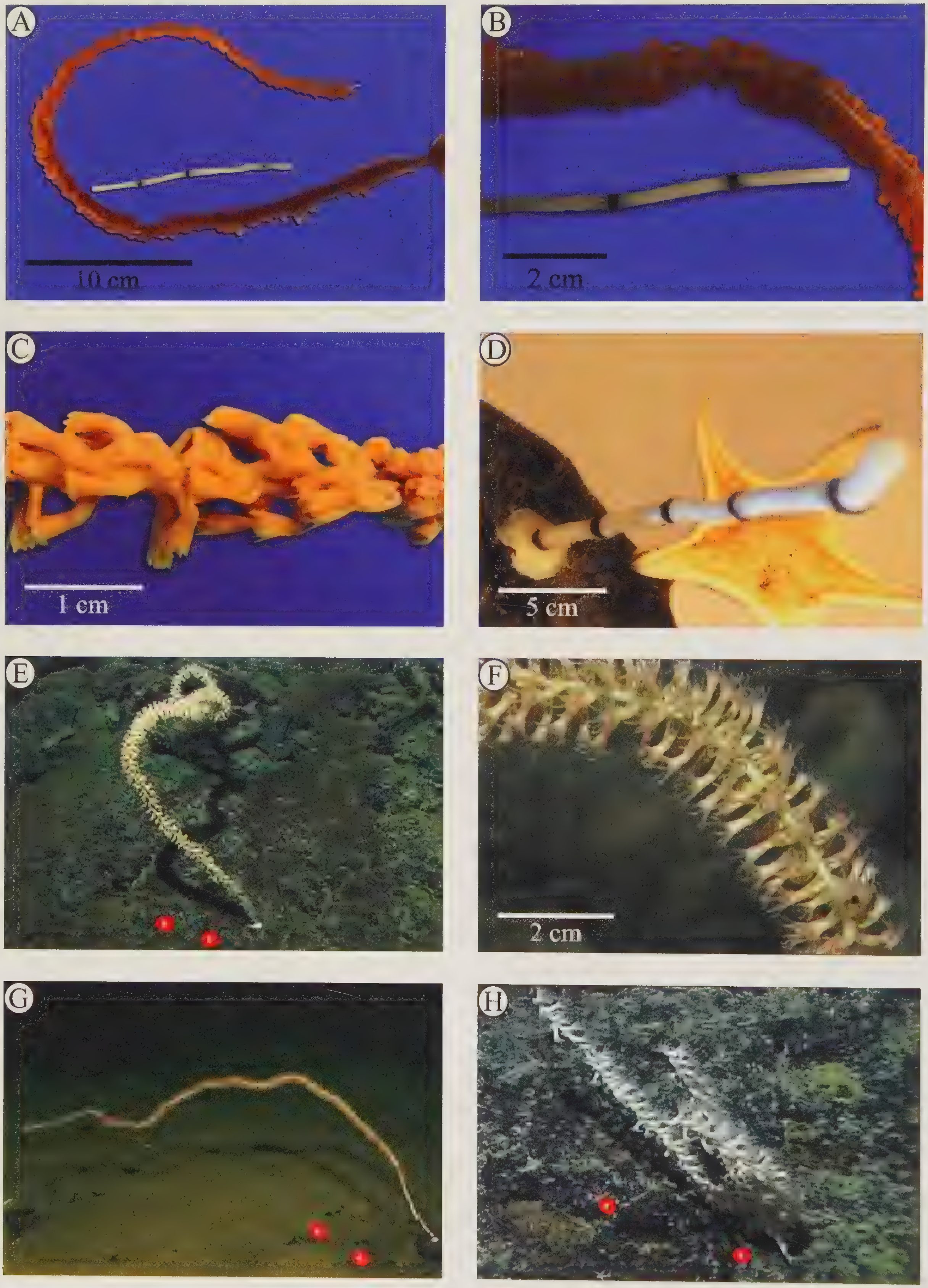
Colonies occasionally host pycnogonids (*Colossendeis* sp.). Colonies were observed with large sections of bare skeleton (up to 50% of the total colony) near the base that were undoubtedly the result of predation, likely by an unknown sea star (see photo G on next page). Actiniarians often colonize those bare sections of skeleton.

Distribution Uncommon. In Alaska – known only from seamounts in the Gulf of Alaska Seamount Province and a single location in the central Aleutian Islands (Fig. 12-3). Specimens have been collected on Welker, Pratt, Quinn, and Giacomini Seamounts; and video observations have additionally been made on Murray Seamount and northwest of Adak Island in the central Aleutian Islands. Elsewhere – unknown.

Habitat In Alaska – occurs singly or a few together on bedrock, fractured bedrock, boulders, and cobbles in areas of low to moderate current, and at depths between 603 and 1925 m. The shallowest observations are from the Aleutian Islands. According to Lapointe and Watling (2015) all known *Bathygorgia* specimens worldwide are from depths greater than 2000 m, highlighting the importance of additional taxonomic work with the Alaska specimens.

Photos A) The fresh top half of a *Bathygorgia* sp. A colony (USNM 1661888) collected on Quinn Seamount at a depth of 900 m. B) A close-up view of the same specimen in photo A. C) A close-up view of a preserved (in ethanol) *Bathygorgia* sp. A specimen (USNM 1082133) collected on Pratt Seamount at a depth of 1873 m. D) The same specimen in photo C showing the holdfast and lower part of the stalk that was denuded when collected, likely from predation. E) A *Bathygorgia* sp. A colony (USNM 1082132) collected on Welker Seamount at a depth of 1130 m. F) A close-up view of the same specimen in photo E. G) A *Bathygorgia* sp. A colony photographed on Quinn Seamount at a depth of 895 m. H) A multi-branched *Bathygorgia* sp. A colony (USNM 1082131) collected on Welker Seamount at a depth of 1132 m. The distance between the red laser marks in photos E, G, and H is 10 cm.

2. *Bathygorgia* sp. A (continued)


A
10 cm
B
2 cm
C
1 cm
D
5 cm
E
F
2 cm
G
H

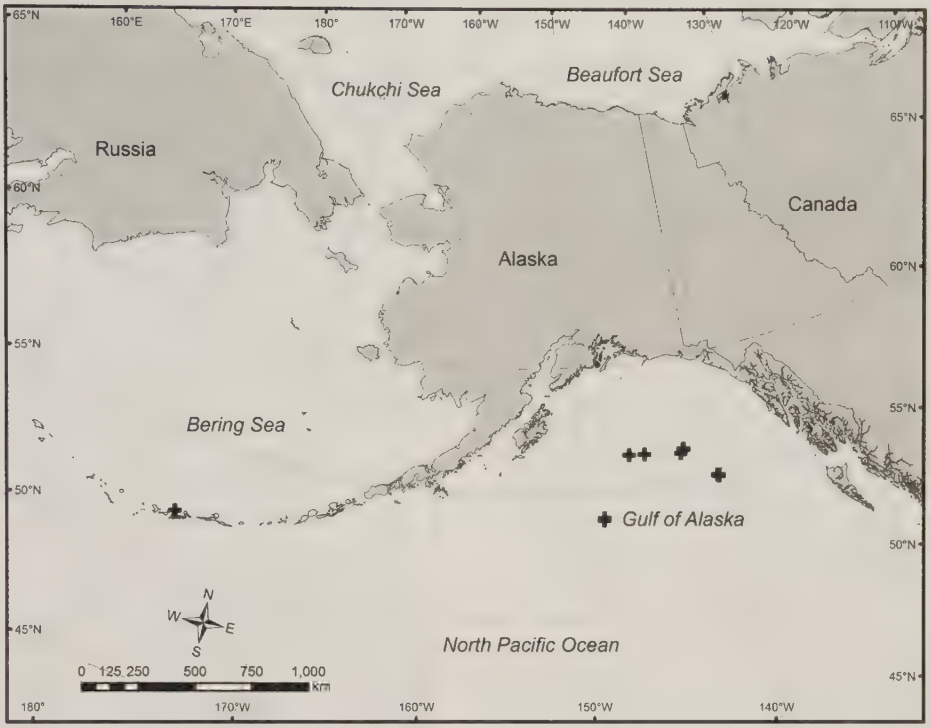

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
60°N
65°N
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
45°N
N
W
E
S
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 12-3

A map of the North Pacific Ocean showing the distribution of *Bathygorgia* sp. A (**+**) in Alaska waters.

3. *Isidella tentaculum* Etnoyer, 2008

Description (Adapted from Etnoyer, 2008) Colonies are typically planar and often perfectly formed like candelabra when mature. The largest colonies are up to 150 cm in height and 150 cm in width, with up to 76 branch tips. Colonies are typically unbranched or monopodial until about 18–20 cm in height and then start to branch dichotomously at fairly regular intervals. Branching is from the nodes and to the 5th order in the largest colonies. The nodes are at highly irregular intervals, sometimes separated by millimeters only, especially on the stem (see photo A) and not every node produces a branching. The color of the nodes appears to be browner than in other bamboo corals; the nodes are also comparatively more recessed (i.e., not level with the surface of the internodes) than those in other bamboo corals. The internodes are robust and solid proximally but less so distally where they are delicate and hollow.

When small monopodial colonies start to branch, the polyps (autozooids) of the unbranched stem apparently develop into elongated basal zooids called sweeper tentacles; these tentacles are restricted to the stem and on the lower parts of the primary branches in some colonies. Sweeper tentacles are obvious, numerous (up to 100), densely packed, and to 40 cm or more in length. Sweeper tentacles have light-colored clavate tips (acrospheres) similar to the tentacles of some corallimorpharian species. The holdfasts are robust, circular, medium-sized (up to 5 cm in diameter), never covered with coenenchyme, and strongly attached to hard substrate. The first internode sometimes has a sharp curve along its length indicative of colonies that settled on vertical surfaces (e.g., sides of boulders) and then turned vertically in the water column.

The polyps (autozooids) are large (6–9 mm in length and 2–3 mm in diameter), tightly packed in whorls of 4–5, and droopy in appearance. The tentacles are relatively short and stubby (2–3 mm in length), each separated by a projecting long (2.5 mm in length) needle-like sclerite. The calyces contain small cylindrical rod-shaped sclerites and flattened scales with medial constriction that are arranged *en chevron* along the adaxial ridge of each tentacle. Small thornstar sclerites are found in the pharyngeal wall and there are no sclerites in the coenenchyme. The polyps are capable of quick retraction when they are disturbed in situ.

The coenenchyme is a very light golden-orange color and so thin and translucent that the skeleton beneath is visible on all branches. The polyps, including the mouth, are a uniform bright to light orange in life, a lighter shade in ethanol, and a darker shade when frozen or dried. The sweeper tentacles are a light orange or pink in life. Colonies exude copious amounts of thick mucus upon collection and this mucus supports a rich bacterial fauna (Penn et al., 2006).

Remarks Sweeper tentacles are unique to this species of bamboo coral in Alaska and their presence is an easily recognized diagnostic feature for accurate identification in situ. The antipatharian *Bathypathes alaskensis* is the only other coral found in Alaska that typically bears sweeper tentacles. Sweeper tentacles are an obvious feature of the corals and provide an excellent indication of bottom current direction, and to some degree, magnitude. The sweeper tentacles are considered modified polyps rather than modified tentacles since there is no apparent intermediate peristome (Etnoyer, 2008).

Elongate sweeper tentacles occur in some scleractinians and other octocorals and serve an agonistic function for space and substratum on which to grow (Sebens and Miles, 1988). In some stony corals, sweeper tentacles serve as probes to detect the approach of competitors, including conspecifics, and suppress encroachment by those competitors by causing injury and extensive tissue necrosis (Lapid and Chadwick, 2006). Nematocysts are present in the sweeper tentacles of *Isidella tentaculum,* implying that they too have an agonistic function (Etnoyer, 2008), and our extensive in situ observations support this premise. Colonies rarely have other sedentary fauna growing nearby, and conspecifics are rarely closer than 30 cm to each other. Surprisingly, this species is heavily preyed upon by at least three mobile predators (see below) that are capable of denuding entire colonies including the sweeper tentacles (Stone, 2014). So it is unlikely that the tentacles develop as a predator defensive mechanism, per se, but we have also observed them growing on broken branches where the colony has sustained wounds.

The age and growth of this species have been studied from specimens collected on seamounts in the Gulf of Alaska (Andrews et al., 2009; USNM 1484154) and off Washington (Roark et al., 2005). Ages can range to 208 ±42 years, with radial-axis growth rates between 0.09 and 0.16 mm/year and linear growth rates of approximately 1.4 cm/year. Another study (Saenger et al., 2017) examined the skeletal composition and biomineralization mechanisms of this species and demonstrated that the skeletons are potential paleoceanographic archives that can be used to reconstruct temperature variations throughout the water column over multiple centuries.

The skeleton (internodes) is composed almost entirely (98.2–99.6%) of high-magnesium calcite (8.1–9.3 mol% $MgCO_3$) with minute amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data). Gulf of Alaska Seamount colonies are often used as platforms for suspension feeding by crinoids (<600 m depth) and the sternostylid crab *Sternostylus iaspus* (>600 m depth). Other associated fauna include the ophiuroid *Ophiolebes brachygnatha* and colonies occasionally host snailfish (*Careproctus* spp.) and the golden king crab (*Lithodes aequispinus*).

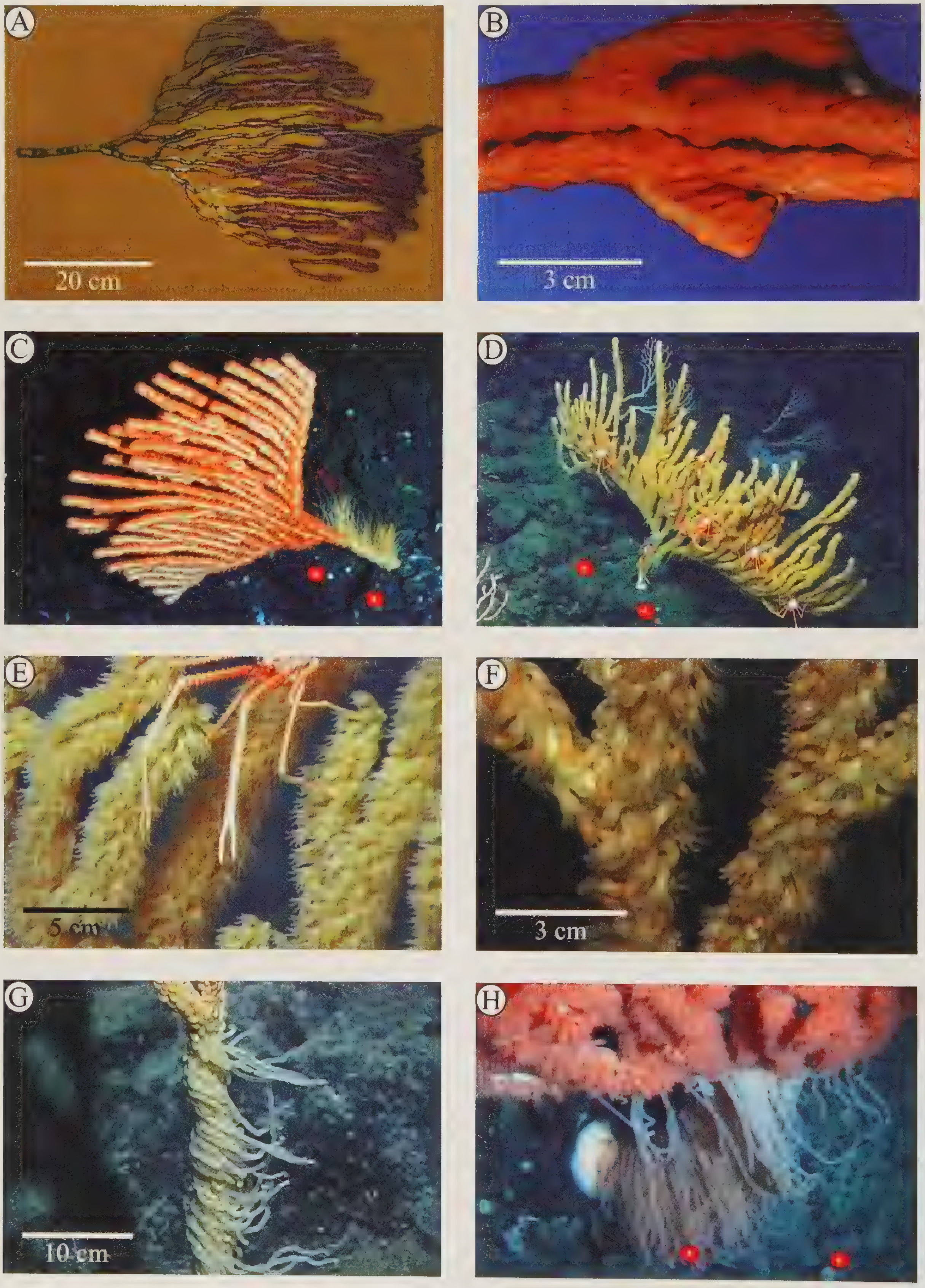
This species is preyed upon by the spiny red sea star (*Hippasteria phrygiana*), calliostomatid snails (*Akoya platinum*), and nudibranchs (*Tritonia* sp.; Stone, 2014). The three predators appear to operate in tandem and together can completely denude large colonies of flesh including sweeper tentacles. The snails and nudibranchs lay their egg cases on the denuded skeletons. Predation by the spiny red sea star on stands of *I. tentaculum* on several Gulf of Alaska seamounts is extensive (senior author, personal observ.).

Distribution This species is one of the most widespread octocorals in the North Pacific Ocean (Fig. 12-4) and is locally abundant. In Alaska – specimens have been collected in the Gulf of Alaska (Dixon Entrance to southwest of Albatross Bank), the Gulf of Alaska Seamount Province (Dickens, Welker, Pratt, Giacomini, and Patton Seamounts), the central Aleutian Islands (southwest of Amlia Island to Stalemate Bank), and the eastern Bering Sea (south of Pribilof Canyon to Navarin Canyon). Colonies have also been observed on video footage collected on Dickens (743–857 m depth), Welker (773–1071 m depth), Pratt (911–1062 m depth), Giacomini (715–890 m depth), Murray (672–984 m depth), and Patton (286–993 m depth) Seamounts. Elsewhere – specimens have been collected from Warwick Seamount (Washington), Monterey Bay (northern California), and Rodriguez Seamount (southern California). This species likely ranges along the west coast of North America from Alaska to southern California.

Habitat In Alaska – seldom found singly, more often in patches (up to 3 colonies/m^2 for adults and 5 colonies/m^2 for juveniles) on bedrock including lava flows, fractured bedrock, and ridges of siltstone at depths between 115 and 1608 m. Records shallower than 400 m are rare and the shallowest records are from the western Aleutian Islands. Elsewhere – found on hard rock at depths between 634 and 907 m.

Photos A) A fresh whole *I. tentaculum* colony (USNM 1484153), except the holdfast, collected west of the Fairweather Ground, eastern Gulf of Alaska, at a depth of 729 m. B) A fresh branch of an *I. tentaculum* colony (ZC-07-02-ROV-04) collected in Zhemchug Canyon in the eastern Bering Sea at a depth of 909 m. C) A large *I. tentaculum* colony photographed near Tanaga Island, central Aleutian Islands, at a depth of 1325 m. D) A large *I. tentaculum* colony photographed on Dickens Seamount at a depth of 758 m. At least six sternostylid crab (*Sternostylus iaspus*) are perched in the colony. The distance between the red laser marks in photos C and D is 20 cm. E) A close-up view of the same specimen in photo D with the polyps fully extended. F) A close-up view of polyps contracting in an *I. tentaculum* colony (USNM 1076664) sampled on Pratt Seamount at a depth of 913 m. G) A close-up view of the sweeper tentacles adorning the stem of an *I. tentaculum* colony (USNM 1082136) sampled on Pratt Seamount at a depth of 1049 m. H) A close-up view of the sweeper tentacles on an *I. tentaculum* colony (USNM 1082145) sampled on Giacomini Seamount at a depth of 727 m. The distance between the red laser marks is 10 cm.

3. *Isidella tentaculum* Etnoyer, 2008 (continued)


A
20 cm
B
3 cm
C
D
E
5 cm
F
3 cm
G
10 cm
H

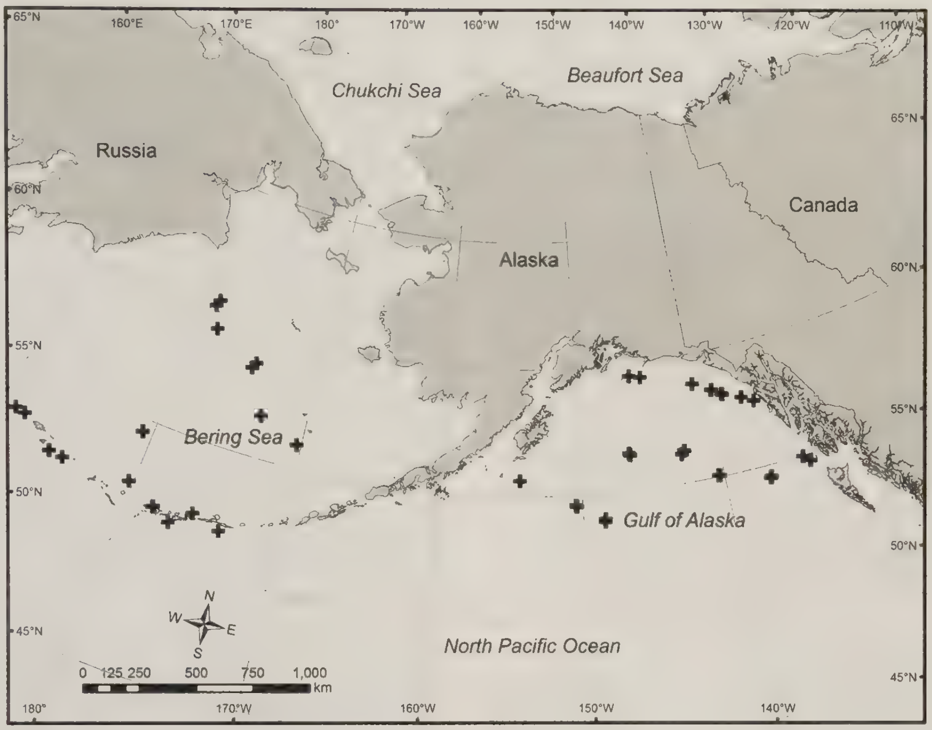

Russia
Chukchi Sea
Beaufort Sea
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
S
E
W
0 125 250 500 750 1,000 km
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
65°N
60°N
55°N
50°N
45°N

Figure 12-4

A map of the North Pacific Ocean showing the distribution of *Isidella tentaculum* (+) in Alaska waters.

4. *Isidella* sp. A

Description Colonies are flabellate and mostly planar with irregular branching starting on or immediately above the holdfast. The largest colonies measure about 35 cm in height and 74 cm in width, with up to 75 branch tips (see photo E). Branching is from the nodes and typically to the 3rd and 4th order in the largest colonies. Branches are quite fragile and easily broken during collection. Polyps mostly alternate in one plane and are long and slender, about three times longer than the width of the branch from which they emanate. Polyps are sparse and moderately spaced. The branches are hollow except for near the base, and the coenenchyme is moderately thick such that the brown nodes are barely visible beneath. Holdfasts are relatively small, circular, and notably discoid and strongly attached to the substrate. The sclerites have not yet been critically examined for this taxon. The coenenchyme in life is a pinkish orange and a yellowish orange preserved in ethanol.

Remarks There are six accepted species of *Isidella* worldwide (WoRMS Editorial Board, 2022); *Isidella tentaculum* is the only named species known to occur in the northern North Pacific Ocean. *Isidella* sp. A is very different morphologically and ecologically from *I. tentaculum* and undoubtedly represents an undescribed species. It co-occurs with *Isidella* sp. B (described on page 214) and conspicuously differs from it.

Some colonies host crinoid associates and small actiniarians attach to bare sections of the skeleton.

Distribution Uncommon. In Alaska – known only from Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 12-5). Elsewhere – unknown.

Habitat In Alaska – occurs singly (rarely more than one) on bedrock and fractured bedrock, including boulders and cobbles. Co-occurs with *Bathygorgia profunda*, *Isidella* sp. B, *Keratoisis* sp. E, and *Narella bayeri* at the shallow end of its depth range. Specimens have been collected at depths between 3993 and 4488 m but colonies have been observed as shallow as 3839 m and as deep as 4643 m (senior author, personal observ.).

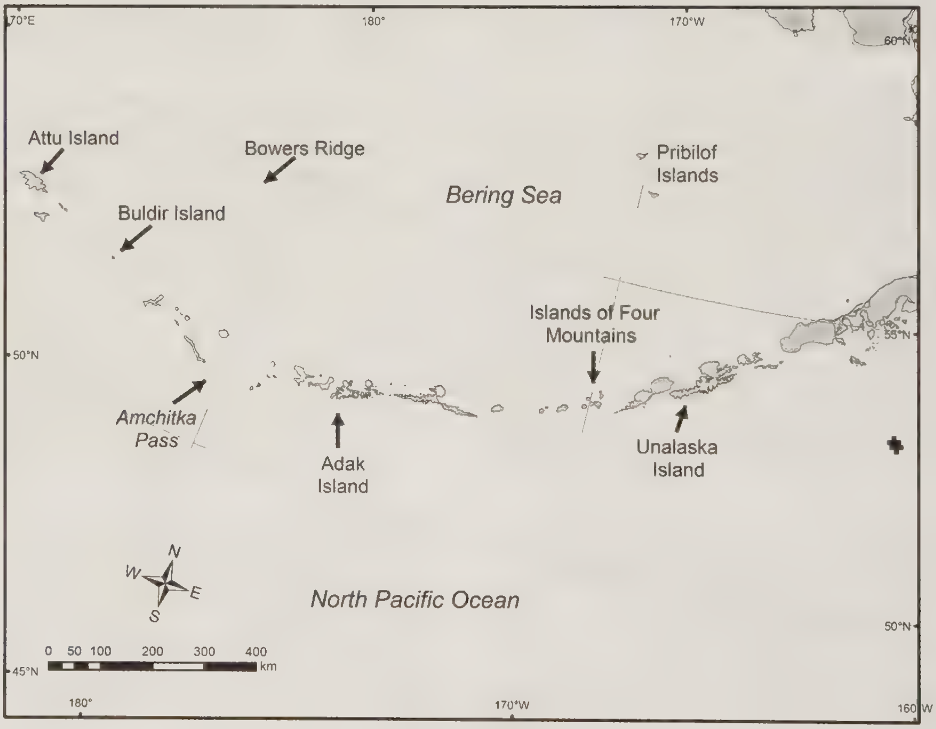
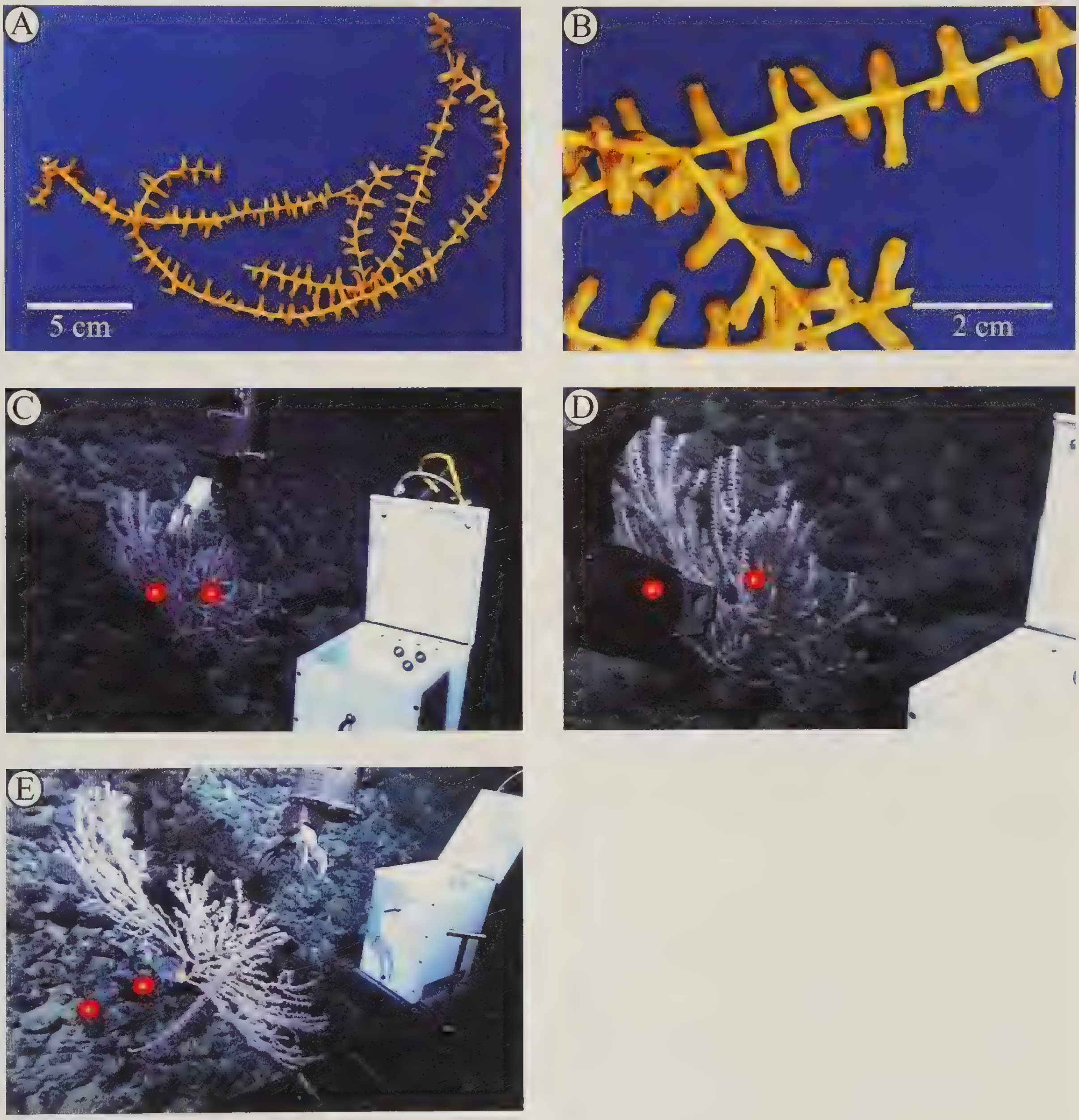


Figure 12-5

A map of the Aleutian Islands showing the distribution of *Isidella* sp. A (+) and *Isidella* sp. B (+) in Alaska waters. The two taxa have nearly coincident distributions.

Photos A) A large branch complex of a preserved (in ethanol) *Isidella* sp. A colony (USNM 1081182) collected on Derickson Seamount at a depth of 4471 m. B) A close-up view of the same specimen in photo A showing the polyp structure and arrangement. C) The same colony in photo A photographed just before collection. D) A close-up view of the same colony in photo C. The distance between the red laser marks in photos C and D is 10 cm. E) An *Isidella* sp. A colony (USNM 1081183) collected on Derickson Seamount at a depth of 4488 m. The distance between the red laser marks is 20 cm.



5. *Isidella* sp. B

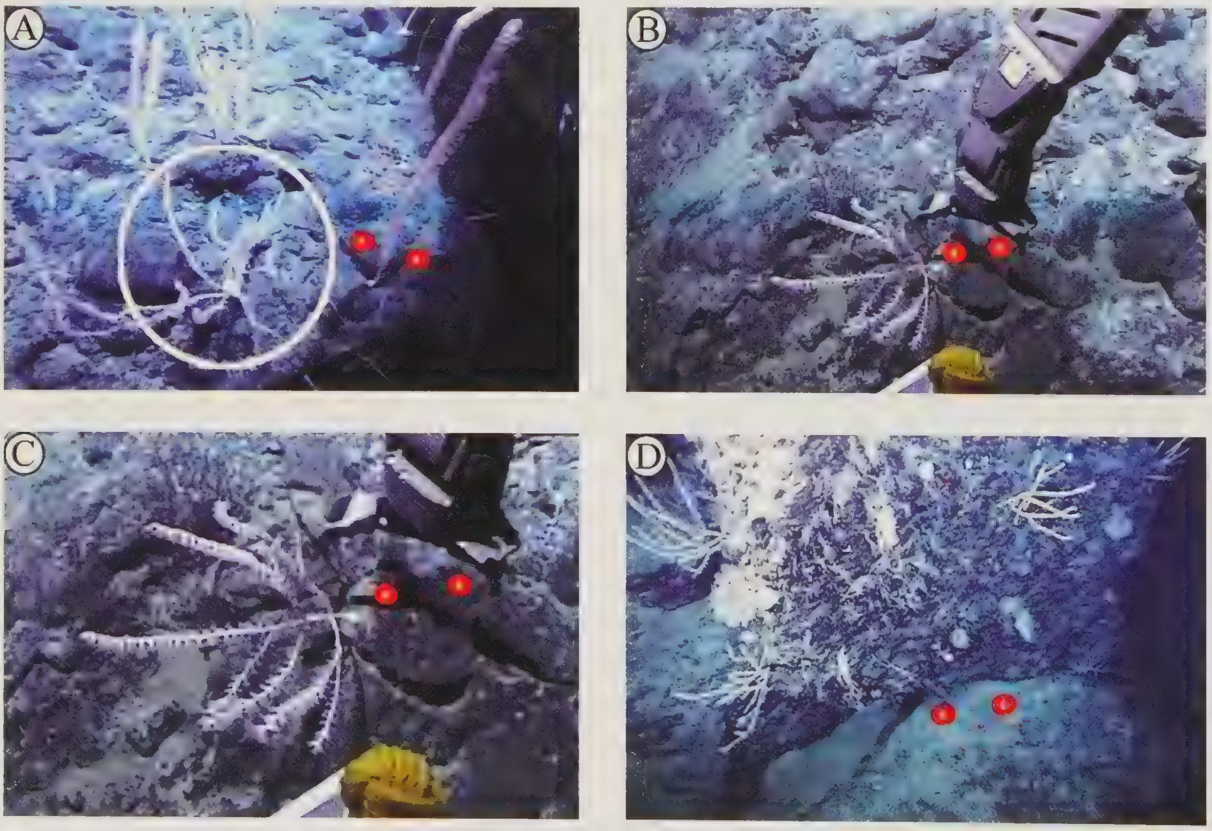
Description Colonies have a somewhat scraggly appearance. Largest colonies are up to 38 cm in height, with 25 branch tips starting on the holdfast or immediately above it; they are mostly branched only to the 2nd order and rarely to the 3rd. Colonies have very thin coenenchyme and are extremely fragile. Polyps appear to be slightly alternate and the short stem, if present, has polyps. Lower branches on the stem are almost opposite. The sclerites have not yet been critically examined for this taxon. Prominent, circular holdfasts are strongly attached and without coenenchyme.

Remarks There are six accepted species of *Isidella* worldwide (WoRMS Editorial Board, 2022); *Isidella tentaculum* is the only species known to occur from the northern North Pacific Ocean. *Isidella* sp. B co-occurs with *Isidella* sp. A and conspicuously differs from it.

Distribution Uncommon but locally abundant. In Alaska – known only from Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 12-5). Elsewhere – unknown.

Habitat In Alaska – typically found in patches, sometimes moderately dense patches (up to 8 colonies/m^2) on flat bedrock and fractured bedrock with *Bathygorgia profunda, Isidella* sp. A, *Keratoisis* sp. E, *Chrysogorgia* sp. B, and *Pseudochrysogorgia* sp. C, and at depths between 3909 and 4643 m.

Photos A) An *Isidella* sp. B colony (USNM 1081179; indicated by the white circle) just before collection on Derickson Seamount at a depth of 4162 m. The colony is in a field of congeners, *B. profunda*, and chrysogorgids. B) An *Isidella* sp. B colony photographed on Derickson Seamount at a depth of 4527 m. C) A close-up view of the same colony in photo B. The distance between the red laser marks in photos A–C is 10 cm. D) A patch of *Isidella* sp. B colonies on a large boulder on Derickson Seamount at a depth of 4025 m. The distance between the red laser marks is 20 cm. E) A field of *Isidella* sp. B colonies mixed with *B. profunda* on Derickson Seamount at a depth of 4163 m.



E
1 m

6. *Keratoisis* sp. A

Description This taxon was determined to be a different species than *Keratoisis* sp. B and *Keratoisis* sp. C based on the complement and sizes of sclerites and analysis of mitochondrial *msh1* DNA sequences and is currently queued for formal description (Watling[12] and France[13]). Colonies are polymorphic, ranging from planar and candelabra-like to slightly bushy or even scraggly. The largest collected specimen has dimensions 64 cm in height, 55 cm in width, with a stem measuring 9 cm in length, an irregular-shaped holdfast measuring 9 mm in diameter, and 39 branch tips. The smallest specimen is 28 cm in height with 8 branch tips. The largest colonies observed in situ measured 92 cm in height, 82 cm in width, with more than 60 branches. Branching is from the internodes, typically only to the 2nd order but occasionally to the 3rd order in larger individuals. Primary branches start at or on the holdfast or on a very short stem. Branches are quite flexible but fragile and very easy to break when sampling. The internodes are relatively close together (about every 4 cm); the nodes are relatively short and black in color.

Polyps are principally aligned in two lateral rows on either side of the branch but are scattered all around. Colonies have large, robust, irregularly shaped holdfasts that are white, without coenenchyme, and strongly attached. The skeletal axis can easily be seen beneath a relatively thin coenenchyme. The sclerites have not yet been critically examined for this taxon. The color of the coenenchyme in life and in ethanol is a very light orange or translucent; the color of the polyps is a darker shade of orange.

Remarks The skeleton (internodes) is composed almost entirely (98.3–99.3%) of high-magnesium calcite (7.4–8.9 mol% $MgCO_3$) with minute amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon but locally abundant. In Alaska – known only from a series of volcanic cones and lava flows in Tanaga Pass in the central Aleutian Islands (Fig. 12-6). Elsewhere – unknown.

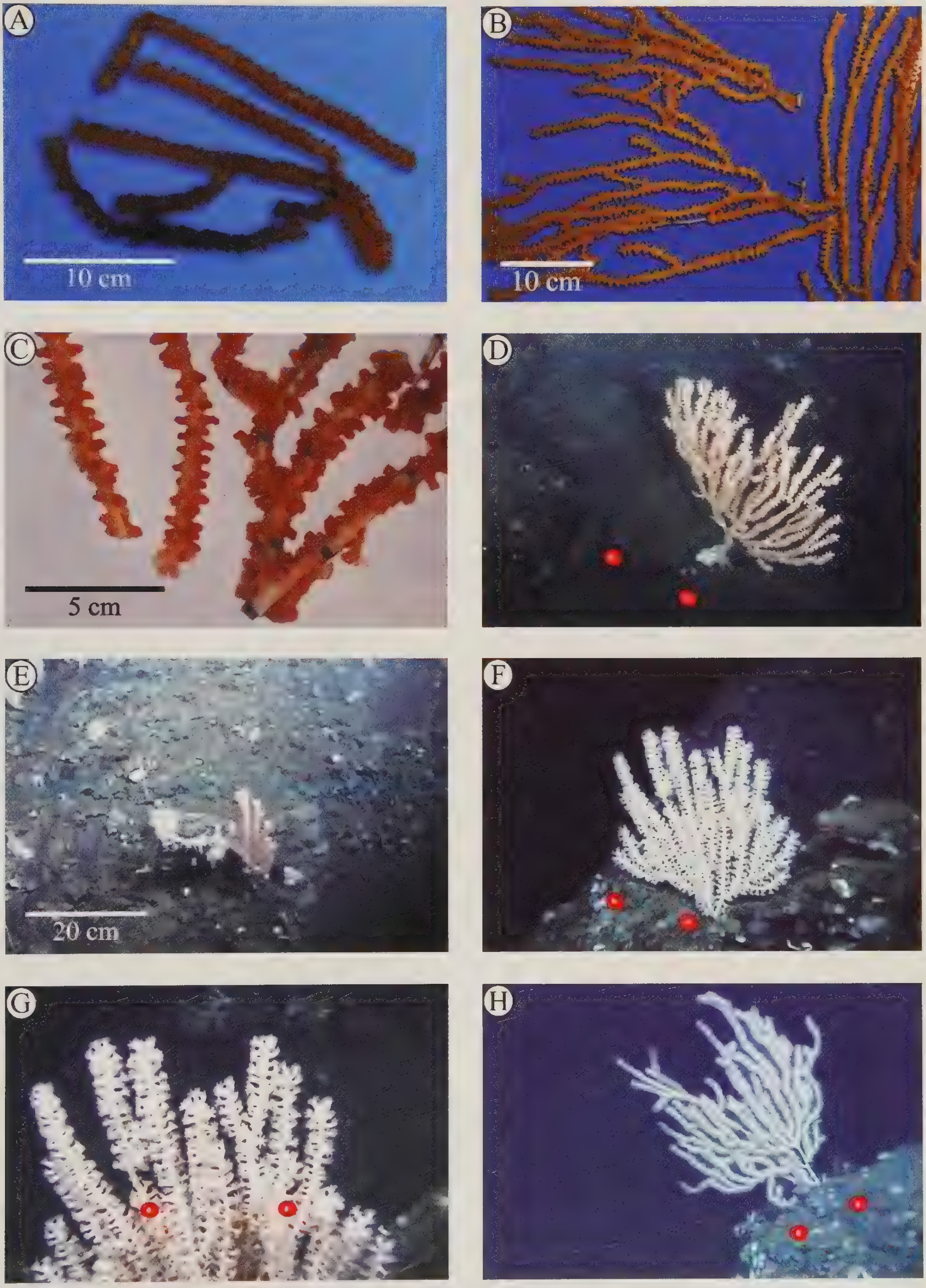
Habitat In Alaska – colonies are found on a series of heavily eroded pinnacles and crags forming a ridge at depths between 1584 and 2035 m. Colonies are restricted to the volcanic ridge and were not observed on boulders scattered in the soft-sediment habitat surrounding the volcanic features. Colonies occur in patches up to 8 colonies/m^2 in areas of moderate current and are associated with hexactinellid sponges (*Caulophacus adakensis* and *Farrea aspondyla*) and the demosponge *Axoniderma corona* in the deeper part of its range. At the shallower part of its range, it co-occurs with *Plumarella echinata* Cairns, 2011 and briefly overlaps with *Isidella tentaculum* where that species becomes the dominant octocoral.

Photos A) Fresh branches of a *Keratoisis* sp. A colony (USNM 1659769) collected northwest of Tanaga Island, central Aleutian Islands, at a depth of 2005 m. B) Fresh large fragments of a *Keratoisis* sp. A colony (USNM 1484161) collected northwest of Tanaga Island at a depth of 2031 m. C) A close-up view of the polyps and branching pattern of the same specimen in photo B, preserved in ethanol. D) The same colony in photo B just before collection. The distance between the red laser marks is 20 cm. E) A *Keratoisis* sp. A colony (USNM 1659769) photographed just before collection. F) A *Keratoisis* sp. A colony photographed in Tanaga Pass at a depth of 1719 m. G) A close-up view of extended polyps in the same colony in photo F. The distance between the red laser marks in photos F and G is 10 cm. H) A large *Keratoisis* sp. A colony photographed in Tanaga Pass at 1618 m. The distance between the red laser marks is 20 cm.

---

[12] Watling, L. 2021. Personal commun. School of Life Sciences, University of Hawai'i at Mānoa, Honolulu, HI 96822.

[13] France, S. 2021. Personal commun. University of Louisiana at Lafayette, Lafayette, LA 70504.


A
10 cm
B
10 cm
C
5 cm
D
E
20 cm
F
G
H

6. *Keratoisis* sp. A (continued)

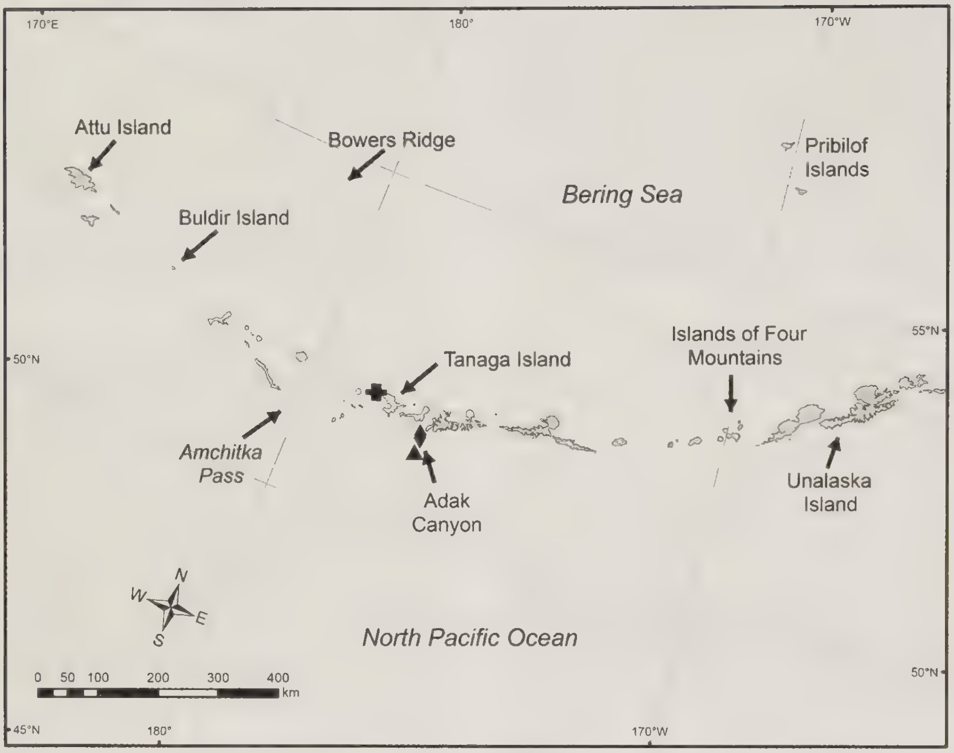

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Tanaga Island
Amchitka Pass
Adak Canyon
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 12-6

A map of the Aleutian Islands showing the distribution of *Keratoisis* sp. A (+), *Keratoisis* sp. B (♦), and *Keratoisis* sp. C (▲) in Alaska waters.

7. *Keratoisis* sp. B

Description This taxon was determined to be a different species than *Keratoisis* sp. A and *Keratoisis* sp. C based on the complement and sizes of sclerites and analysis of mitochondrial *msh1* DNA sequences and is currently queued for formal description (Watling[12] and France[13]). Colonies are straggly but appear to be planar in broad view, with irregular branching that starts close to the holdfast; there are up to 22 branch tips to the 3rd order. Maximum size is 35 cm in height and 35 cm in width. Colonies are somewhat flexible and not particularly fragile. Branching occurs along the internodes; the nodes are very short and dark black in color. Polyps are quite crowded, principally on three sides of the branches, and are slightly darker in color than the relatively thin coenenchyme that reveals the axial skeleton underneath. The slightly conical polyps are small (6 mm in height by 3–4 mm in width) and appear to be mostly retractable in fresh specimens. The sclerites have not yet been critically examined for this taxon. The holdfast is relatively small but robust, irregularly cup-shaped, and white and reflective in situ. Color of the coenenchyme is light to medium orange in life.

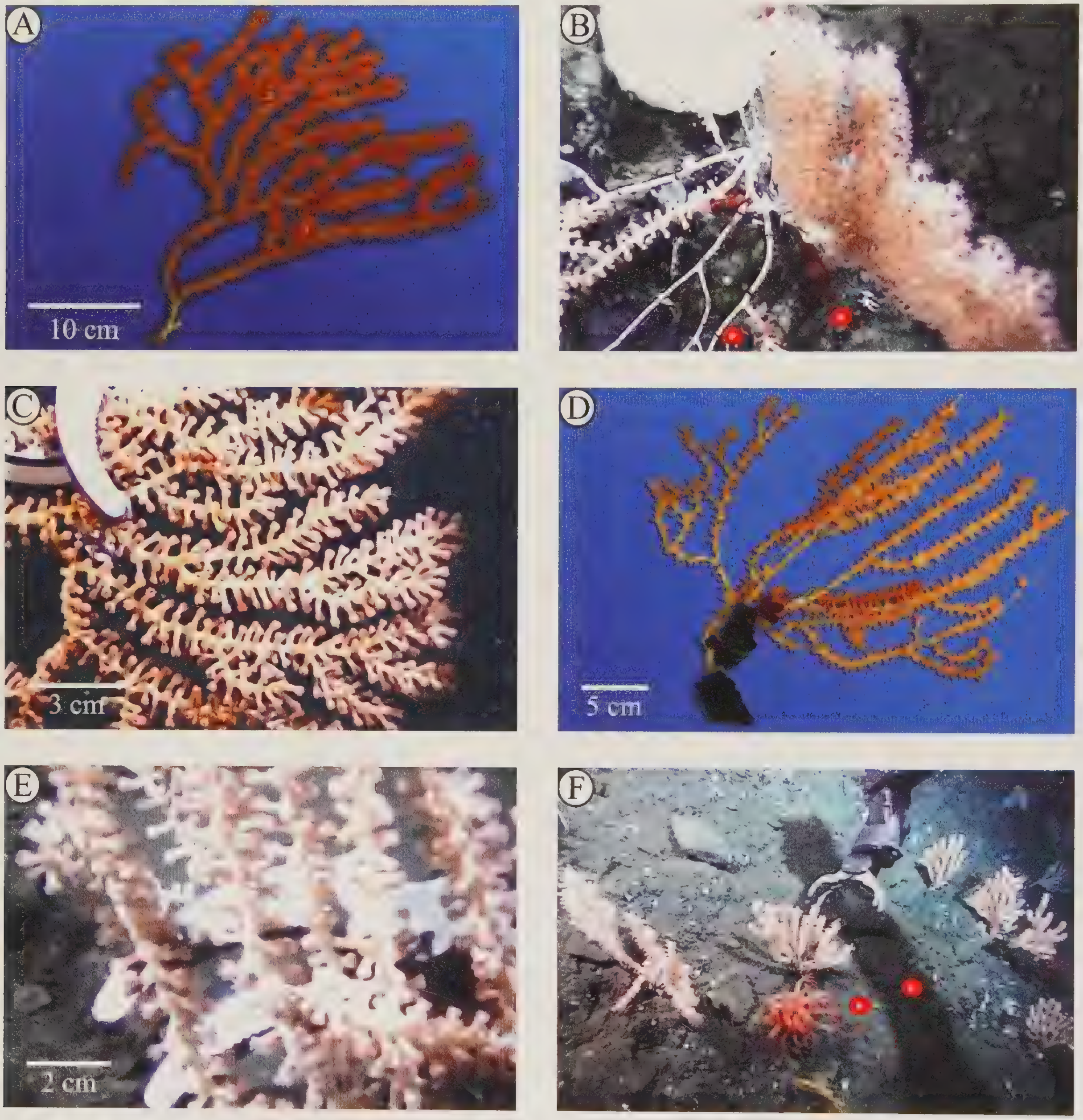
Remarks The skeleton (internodes) is composed almost entirely (96.5–99.3%) of high-magnesium calcite (7.6–9.4 mol% $MgCO_3$) with minute amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon but locally abundant (Fig. 12-6). In Alaska – known only from two locations in Adak Canyon, central Aleutian Islands. Of the three locations in Adak Canyon that have been explored within the known depth range of this species, it was common at one site; four specimens were observed at the second site; and it was not observed at the third site. These observations indicate that this species has a very limited geographical range. Elsewhere – unknown.

Habitat In Alaska – occurs in relatively rough habitat with moderate currents and grows on fractured bedrock, boulder, conglomerate, and siltstone at depths between 1716 and 2044 m. It occurs in dense patches (up to 7 colonies/m^2) with the congener *Keratoisis* sp. C, *Acanthogorgia spissa*, and an unidentified species of *Heteropolypus*.

Photos A) A fresh large portion of a *Keratoisis* sp. B colony (USNM 1484160) collected in Adak Canyon in the central Aleutian Islands at a depth of 1715 m. B) The same colony in photo A in situ with polyps fully extended. A partially skeletonized colony (at left) shows the branching pattern with nodes and internodes. The distance between the red laser marks is 10 cm. C) A close-up view of the same colony in photo A during collection. D) A fresh whole *Keratoisis* sp. B colony (USNM 1659765) collected in Adak Canyon at a depth of 1717 m. E) A close-up view of the same colony in photo D with polyps in various states of contraction. F) The same colony in photo D in situ (at center) just before collection. The distance between the red laser marks is 20 cm.

7. *Keratoisis* sp. B (continued)


A
10 cm
B
C
3 cm
D
5 cm
E
2 cm
F

8. *Keratoisis* sp. C

Description This taxon was determined to be a different species than *Keratoisis* sp. A and *Keratoisis* sp. B based on the complement and sizes of sclerites and analysis of mitochondrial *msh1* DNA sequences and is currently queued for formal description (Watling[12] and France[13]). It co-occurs with *Keratoisis* sp. B but apparently differs in being more robust, having fewer branches and more polyps that are spiraled on all sides of the branches, and having a darker orange color (see photo B on next page). Colonies are mostly planar, with irregular branching that starts close to the holdfast; they have up to 15 branch tips to the 3rd order. Maximum size is 42 cm in height and 34 cm in width. Colonies are somewhat flexible and not particularly fragile. Branching occurs along the internodes; the nodes are short and dark black in color. Polyps are quite crowded on all sides of the branches and are slightly darker in color than the relatively thin coenenchyme that reveals the axial skeleton only along the stem. The cylindrical polyps are small (7 mm in height by 4 mm in width) and appear to be mostly retractable in fresh specimens. The sclerites have not yet been critically examined for this taxon. The holdfast is moderately large and robust, more or less cup-shaped or discoid, and white and reflective in situ (see photo D on next page). This species secretes copious amounts of mucous upon collection. Color of the coenenchyme is medium to dark orange in life.

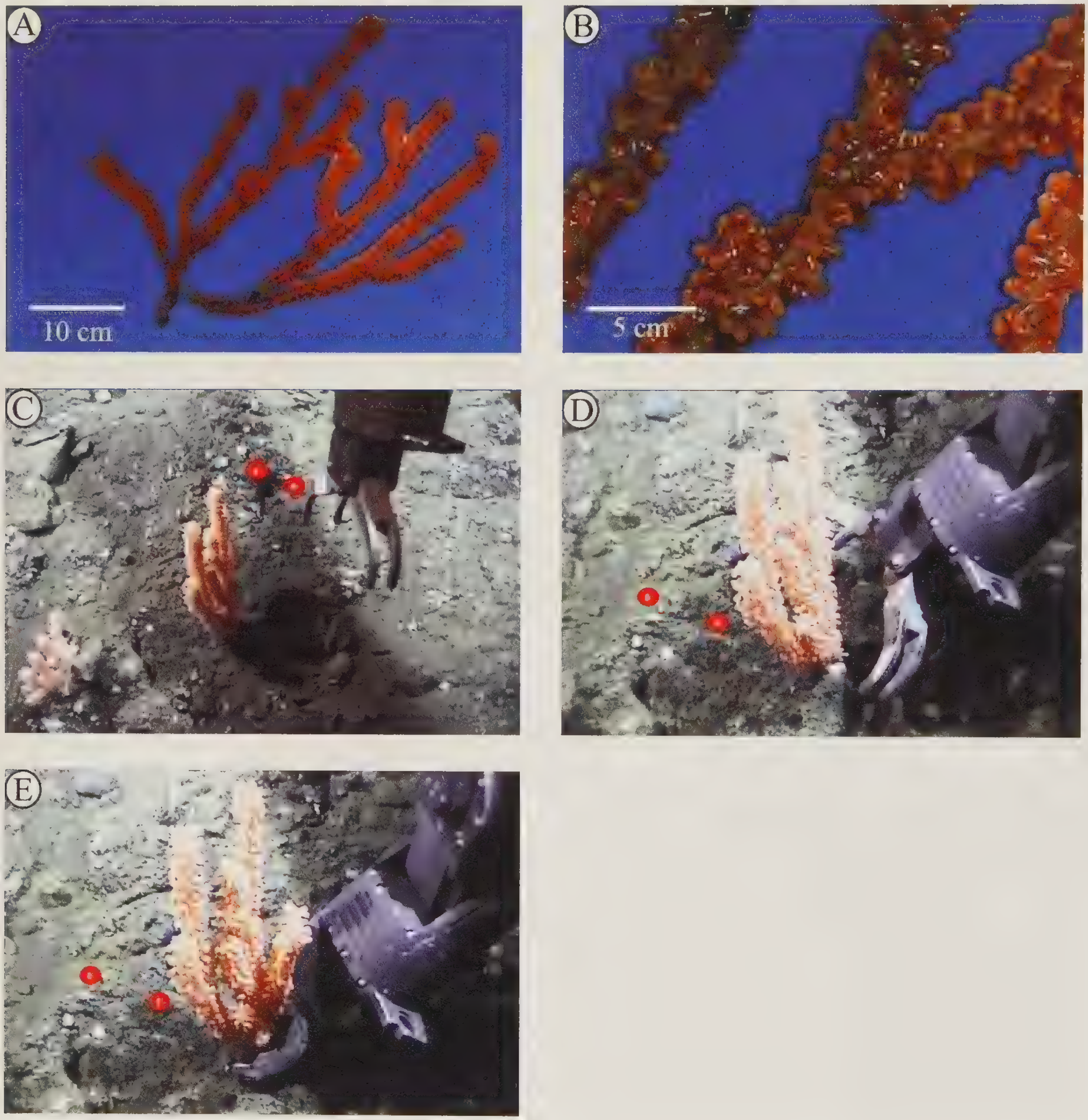
Remarks The skeleton (internodes) is composed almost entirely (97.0%) of high-magnesium calcite (8.9 mol% $MgCO_3$) with minute amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – known only from a single location in Adak Canyon, central Aleutian Islands (Fig. 12-6). It occurs at that site with *Keratoisis* sp. B but appears to be much less common than the former species in patches where they co-occur. Elsewhere – unknown.

Habitat In Alaska – occurs in relatively rough habitat with moderate currents and grows on fractured bedrock, conglomerate, and siltstone at depths between 1715 and 1988 m. It occurs in dense patches (up to 7 colonies/m^2) with the congener *Keratoisis* sp. B, *Acanthogorgia spissa*, and an unidentified species of *Heteropolypus*.

Photos A) A fresh whole (except the holdfast) *Keratoisis* sp. C colony (USNM 1659767) collected in Adak Canyon, central Aleutian Islands, at a depth of 1715 m. B) A close-up of the same specimen in photo A. C) The same colony in photo A prior to collection. A *Keratoisis* sp. B colony is at the lower left. D) A close-up view of the same colony in photo C prior to collection showing the highly reflective holdfast. E) An alternate close-up view of the same colony in photo D showing the polyps. The distance between the red laser marks in photos C–E is 10 cm.

8. *Keratoisis* sp. C (continued)


A
10 cm
B
5 cm
C
D
E

9. *Keratoisis* sp. D

Description Colonies are bushy with a straggly appearance; branching typically starts from a very short stem; branching is to the 3rd order only. The largest colonies are to about 30 cm in height and width with no more than 20 branch tips. Branching is at the internodes; the nodes are notably narrow and occur at semi-irregular intervals (about 16–21 mm apart). Holdfasts are small (up to 13 mm in diameter) and circular, typically without coenenchyme, but may be robust and heavily calcified. Colonies are fragile and easily broken during sampling.

Polyps appear to be alternately or randomly situated on all sides of the branches, giving the appearance of being spiraled. Polyps (expanded) are long and slender (up to 10.0 mm in length by 3.0 mm in width), taper slightly distally, have a red-colored mouth, and are thicker than the slender branches that bear them. Tentacles are blunt-tipped, about 1.4 mm in length, and bear 8–9 pairs of pinnules.

The sclerites have not yet been critically examined for this taxon. The coenenchyme is variably thick but often translucent enough that the narrow, dark brown nodes are visible along most of the branches basally. The color of the coenenchyme is light orange to cream in life and light orange in ethanol-preserved specimens.

Remarks Associated fauna include sternostylid (*Sternostylus iaspus*) and munidopsid crabs (*Munidopsis* sp.); ophiuroids and actiniarians occasionally attach to bare sections of the skeleton. This taxon overlaps with the primnoid *Calyptrophora laevispinosa* in the deeper part of its depth range and has similar morphology with juvenile colonies of the latter species. Its fragility sets it apart, however, as *C. laevispinosa* is very difficult to tear upon collection.

Distribution Uncommon. In Alaska – known only from seamounts in the Gulf of Alaska Seamount Province (Fig. 12-7). Specimens have been collected from Dickens, Densen, Welker, and Pratt Seamounts and video observations have additionally been collected on Giacomini, Murray, and Patton Seamounts. It is particularly common on Murray Seamount. Elsewhere – unknown.

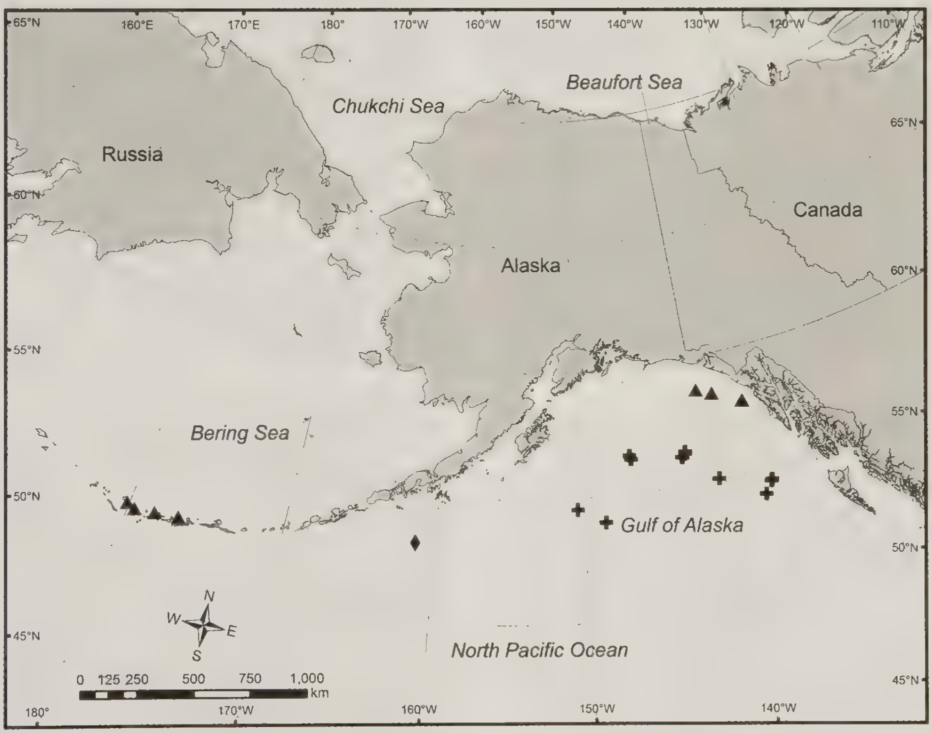
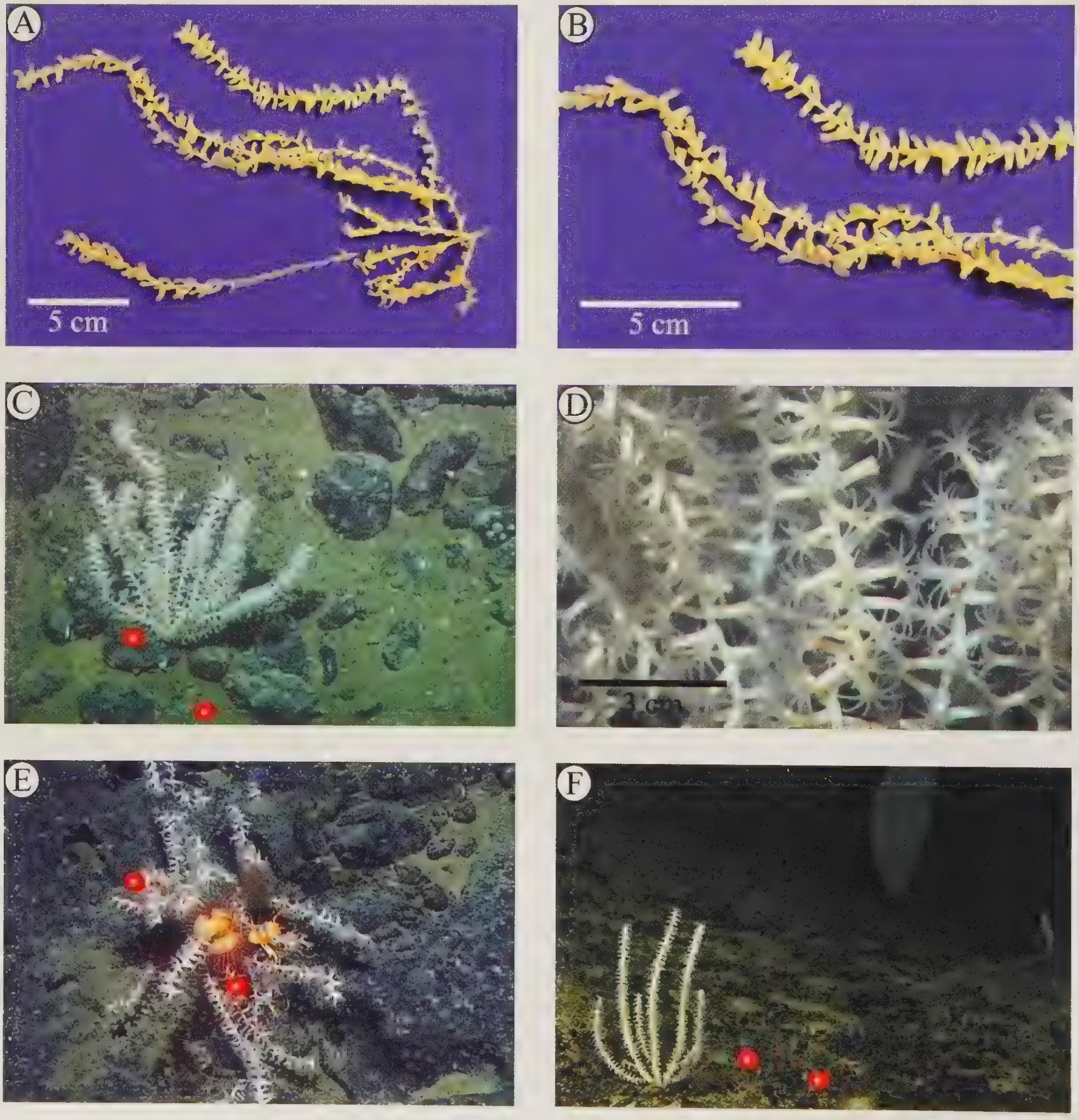


Figure 12-7

A map of the North Pacific Ocean showing the distribution of *Keratoisis* sp. D (+), *Keratoisis* sp. E (♦), and *Keratoisis* sp. F (▲) in Alaska waters.

Habitat In Alaska – these corals typically occur singly, occasionally 2–4 colonies together, on bedrock, fractured bedrock, boulders and cobbles, and occasionally at the base of hexactinellid sponges, at depths between 598 and 2689 m.

Photos A) A large portion of a preserved (in ethanol) *Keratoisis* sp. D colony (USNM 1076661) collected on Pratt Seamount at a depth of 1210 m. B) A close-up view of the same specimen in photo A showing details of the polyps. C) The same colony in photo A just before collection. D) A close-up view of the same colony in photo A. E) A *Keratoisis* sp. D colony (USNM 1076659) photographed just before collection on Welker Seamount at a depth of 1096 m. An actiniarian is attached to a bare section of the skeleton and a munidopsid crab (*Munidopsis* sp.) uses the colony as refuge. F) A *Keratoisis* sp. D colony photographed on Giacomini Seamount at a depth of 2477 m. Note the juvenile colony in the background (at far right). The distance between the red laser marks in photos C, E, and F is 10 cm.



10. *Keratoisis* sp. E

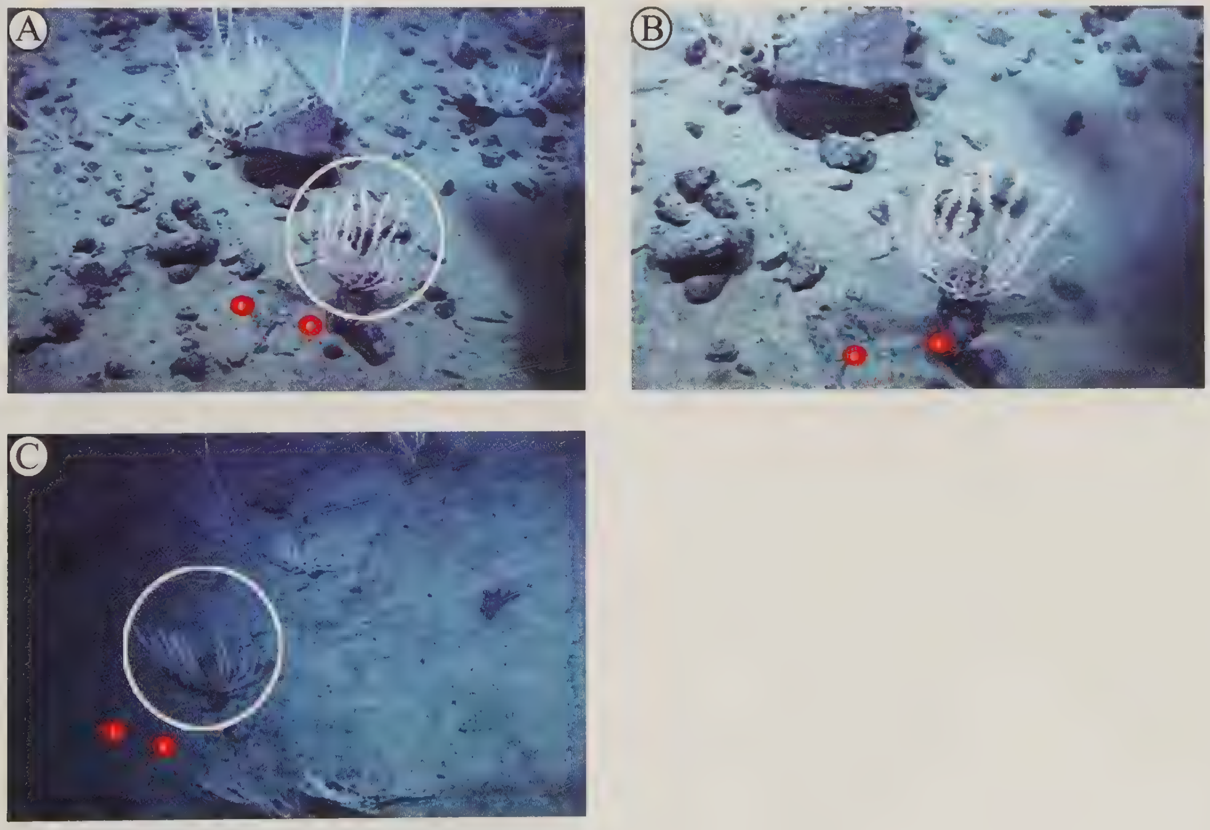
Description The single collected specimen (USNM 1081149) is bushy but somewhat fan-shaped and relatively planar. It measures 34 cm in height and 44 cm in width with 16 branch tips; larger colonies have been observed in situ that have between 20 and 25 branch tips. Branching is from the internodes and starts at the holdfast or from a very short stem; branching is typically only to the 2nd order and rarely to the 3rd order. Branches appear rubbery and are more robust than those in *Isidella* sp. A and *Isidella* sp. B, with which it co-occurs, but they are easily broken upon collection. The polyps are tightly packed on all sides of the branches. The holdfast is small, discoid, firmly attached to the substrate, and devoid of coenenchyme. The coenenchyme is thick except near the holdfast, and is light orange to light pink in color. The sclerites have not yet been critically examined for this taxon.

Remarks This taxon is known from only one collected specimen and many video observations made nearby. There are no other *Keratoisis* known from these bathyal depths in Alaska waters.

Distribution Locally abundant. In Alaska – known only from Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 12-7). Elsewhere – unknown.

Habitat In Alaska – almost always occurs singly but occasionally in patches of 5 colonies/m^2 in cobble field habitat (fractured bedrock) with *Isidella* sp. A, *Isidella* sp. B, and a few *Bathygorgia* cf. *profunda*. Found at depths between 3990 and 4373 m and is more common in the shallower part of its depth range.

Photos A) A *Keratoisis* sp. E colony (USNM 1081149; indicated by the white circle) photographed just before collection on Derickson Seamount at a depth of 4098 m. The colony is in a field dominated by *Isidella* sp. B. B) A close-up view of the same colony in photo A. C) A *Keratoisis* sp. E colony (indicated by the white circle) photographed on Derickson Seamount at a depth of 4115 m. The distance between the red laser marks in photos A–C is 20 cm.



11. *Keratoisis* sp. F

Description Colonies are large, generally bushy or straggly, and even scraggly as they are often damaged or preyed upon and exhibit large areas of bare or broken skeleton. The largest colonies are to at least 120 cm in height and 100 cm in width, with more than 100 branch tips. The main axis and lower branches are robust and solid; distal branches are delicate, fragile, and hollow. Branching is highly irregular and from the internodes that provide for twisting branches that occasionally anastomose (see photo B). The black nodes are extremely short (more so than any other taxon listed here), especially basally, but gradually increasing in length distally. Primary branches emanate from the holdfast or immediately above it. The axial skeleton has obvious linear striations. The holdfast is large, irregular, devoid of coenenchyme, and strongly attached to the substrate (i.e., the primary branch will typically break near the base before the holdfast).

The polyps are large, tightly packed all around the branches, not completely retractile, and with obvious fusiform, sharp marginal spines projecting at the base of the tentacles. The coenenchyme is generally thick but the holdfast and lower branches are often devoid of flesh. The sclerites have not yet been critically examined for this taxon. The coenenchyme including the polyps is a uniform bright to medium orange in life and a lighter orange shade when dried.

Remarks This is a very large and conspicuous bamboo coral that somehow largely escaped notice until recently, despite being locally common within the depth range of historical fishing activities and traditional research surveys.

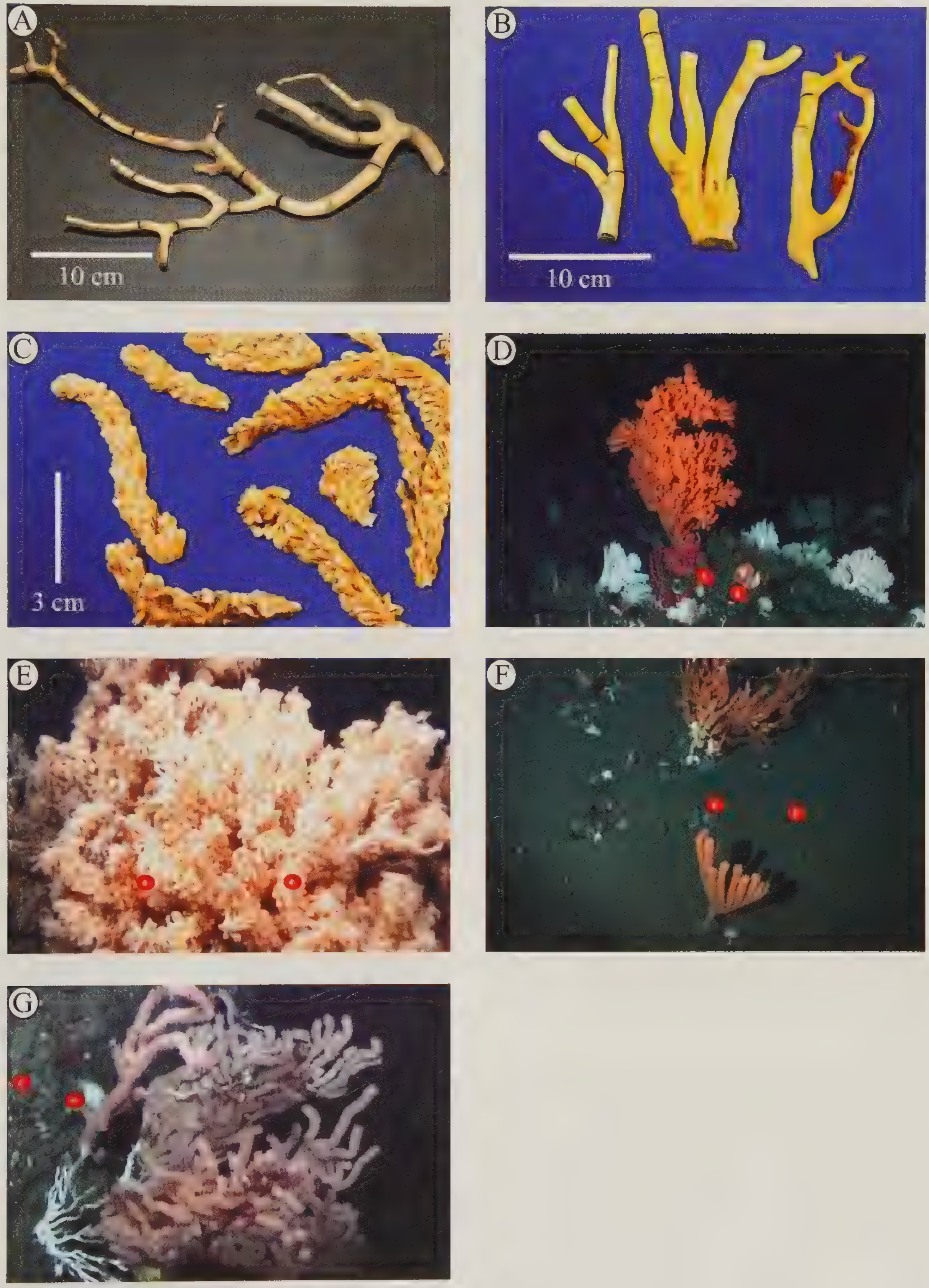
The age and growth of this species have been studied from a specimen (USNM 1485149) collected in the eastern Gulf of Alaska with age estimated at 116 ±29 years, a radial-axis growth rate of approximately 0.056 mm/year, and a linear growth rate of approximately 10 mm/year (Andrews et al., 2009). Another study (Saenger et al., 2017) examined the skeletal composition and biomineralization mechanisms of this species and demonstrated that the skeletons are potential paleoceanographic archives that can be used to reconstruct temperature variations throughout the water column over multiple centuries.

Keratoisis sp. F is typically found in complex habitats and is an excellent indicator species of vulnerable marine ecosystems including coral gardens. This species co-occurs in the central Aleutian Islands with *Primnoa wingi* Cairns and Bayer, 2005 and the two species are easily mistaken for each other in situ. *Primnoa wingi* has a very stout holdfast and stem that are completely covered with coenenchyme whereas *Keratoisis* sp. F has a massive, irregular holdfast that is almost always bare skeleton. Colonies often present evidence of predation, likely from the spiny red sea star (*Hippasteria phrygiana*) that has been observed preying on nearby *Isidella tentaculum* (see photo G), and bare skeletons of Aleutian Island colonies are occasionally covered with *Clavularia* sp. A.

Distribution Uncommon but locally abundant. In Alaska – this taxon is known from the continental slope of the eastern GOA and the island arc slope of the central Aleutian Islands (Fig. 12-7). Elsewhere – unknown.

Habitat In Alaska – occurs on hard substrate including bedrock, fractured bedrock, boulders, and large cobbles at depths between 574 and 1563 m. It occurs in low density patches with *I. tentaculum* in the eastern GOA and is found in coral garden habitat in northern Amchitka Pass in the central Aleutian Islands.

Photos A) A dried large medial branch complex of *Keratoisis* sp. F (USNM 1484159) collected in the eastern GOA at a depth of 760 m. B) A dried and varnished *Keratoisis* sp. F specimen (USNM 1484157) collected in the eastern GOA at a depth of 697 m. The photo shows the colony base (just above the holdfast, at center) and several branch sections. C) Dried branch tips of *Keratoisis* sp. F (USNM 1484158) collected in the eastern GOA at a depth of 578 m. D) A large *Keratoisis* sp. F colony photographed in northern Amchitka Pass in the central Aleutian Islands at a depth of 849 m. The distance between the red laser marks is 20 cm. E) A close-up view of the same colony in photo D. The distance between the red laser marks is 10 cm. F) A cluster of three *Keratoisis* sp. F colonies (top) photographed northwest of Adak Island in the central Aleutian Islands at a depth of 725 m. An *I. tentaculum* colony is in the foreground. The distance between the red laser marks is 50 cm. G) A *Keratoisis* sp. F colony with evidence of predation photographed northwest of Adak Island at a depth of 1462 m. The distance between the red laser marks is 20 cm.


A
10 cm
B
10 cm
C
3 cm
D
E
F
G

12. *Keratoisis* sp. G

Description Colonies are bushy but somewhat fan-shaped and relatively planar with irregular branching. The largest colonies measure 96 cm in height and 77 cm in width, with almost 100 branch tips. Branching in the largest specimens is to the 4th order but in smaller specimens typically only to the 2nd order. Branching is from the internodes and starts at the holdfast or from a very short stem. Branches are quite flexible but are easily broken upon collection, and larger colonies often have broken and bare sections of skeleton that likely result from unobserved predation. Nodes are relatively short and dark brown in color. The polyps are tightly packed on all sides of the branches, apparently in four rows. The short, stout, and conical polyps bear short and stubby tentacles. The sclerites have not yet been critically examined for this taxon. The holdfast is moderately large and robust, irregularly shaped, firmly attached to the substrate, and devoid of coenenchyme as are many of the lower branches. The coenenchyme is thick where present, and is orange to light pink in life and a yellowish-orange in ethanol.

Remarks This species is known from two collected specimens and multiple video observations on the southeast flank of Giacomini Seamount. It is a different morphotype than all other *Keratoisis* listed in this guide.

Growth rate and age were studied for a morphotype collected on Davidson Seamount off northern California at a depth of 1455 m, with age estimated at >145 years and a moderate linear growth rate of 14–28 mm/year (Andrews et al., 2009). The spider crab *Macroregonia macrochira* occasionally uses colonies as refuge.

Distribution Uncommon. In Alaska – known only from Giacomini Seamount in the Gulf of Alaska Seamount Province (Fig. 12-8). Elsewhere – unknown but a morphotype and video observations were collected on Davidson Seamount off northern California (see Figure 1B in Andrews et al., 2009).

Habitat In Alaska – grows on basalt bedrock (lava flows) and fractured bedrock (boulders and cobbles) at depths between 1689 and 1726 m. Colonies occur singly, spaced out by 5 m or more, and occasionally grow at the bases of hexactinellid sponges. Elsewhere – on fractured bedrock at 1400–1455 m depth.

Photos A) Branches (preserved in ethanol) of *Keratoisis* sp. G (USNM 1076666) sampled on Giacomini Seamount at a depth of 1726 m. B) A close-up view of the same specimen in photo A showing branching at the internodes. C) A zoomed-in view of the same specimen in photo A. D) The same colony in photo A growing at the base of a hexactinellid sponge (*Chonelasma oreia*) photographed just before collection. E) A zoomed-in view of the same colony in photo D. F) A *Keratoisis* sp. G colony (USNM 1082147) sampled on Giacomini Seamount at a depth of 1689 m. G) A *Keratoisis* sp. G colony photographed on Giacomini Seamount at a depth of 1692 m. The spider crab *Macroregonia macrochira*

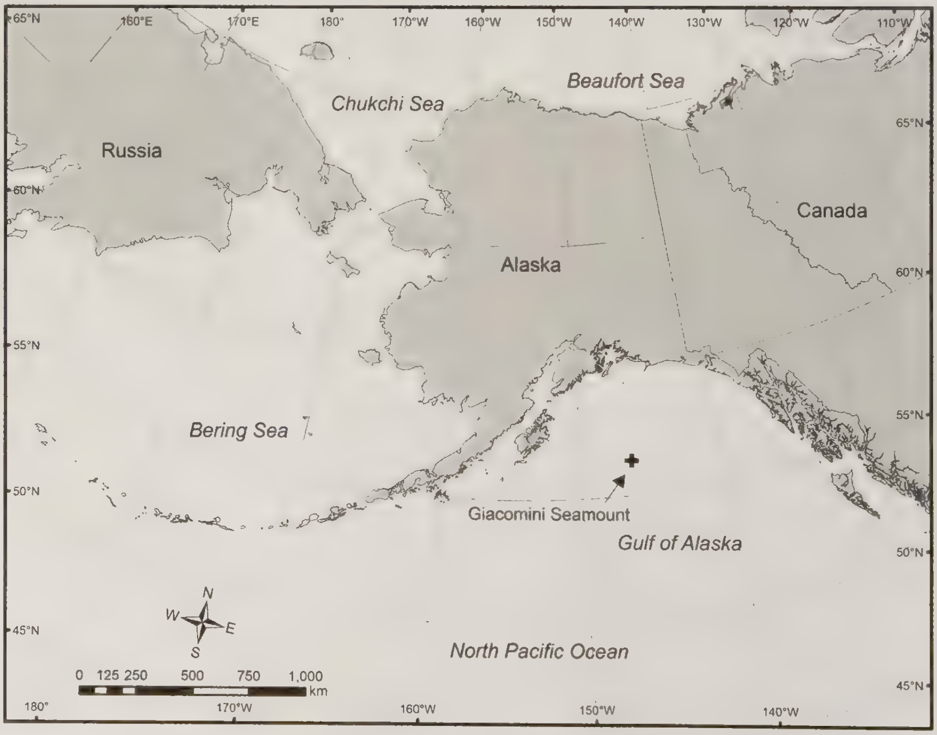
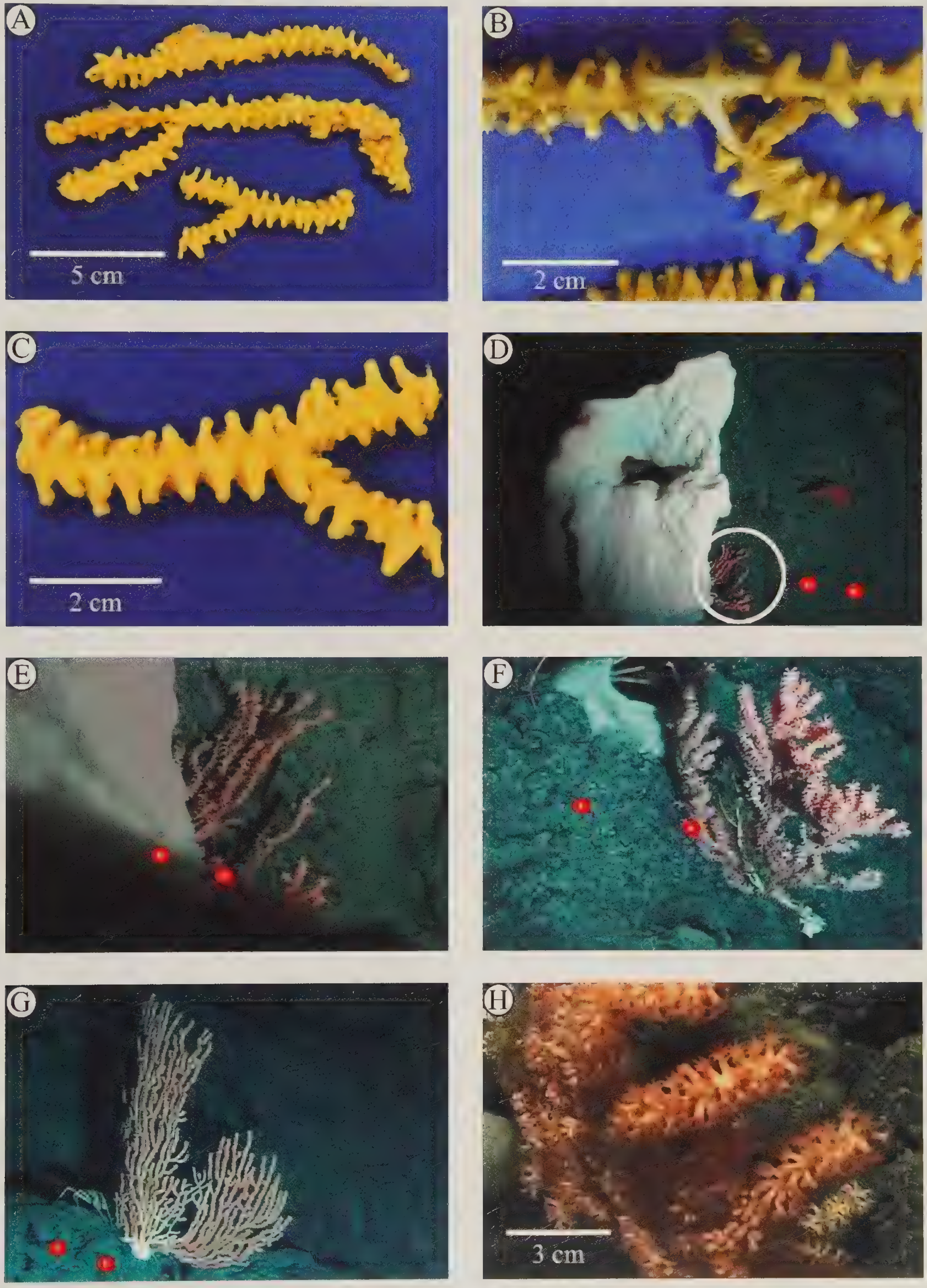


Figure 12-8

A map of the North Pacific Ocean showing the distribution of *Keratoisis* sp. G (+) in Alaska waters.

uses the colony as refuge. The distance between the red laser marks in photos D–G is 20 cm. H) A close-up view of a *Keratoisis* sp. G colony photographed on Giacomini Seamount at a depth of 1690 m.


A
5 cm
B
2 cm
C
2 cm
D
E
F
G
H
3 cm

13. *Orstomisis* sp.

Description The single collected specimen consists of five branches that emanate from two main stalks off a very short stem above the holdfast; the longest branch is about 18 cm in length and 3.3 mm in average width. Branching is apparently from the barely visible nodes; in this genus the nodes are typically overgrown by the calcareous internodes especially near the base (Bayer, 1990). The branches are fairly flexible and a good indicator of water current direction. Polyps are sparsely populated, principally on two sides of the branches, and are relatively long and narrow when fully expanded, but short and squat when retracted. The polyps form short, cylindrical calyces into which the tentacles can be fully retracted. The coenenchyme is thin and the holdfast and bottom branches are typically without coenenchyme. Colonies have prominent white, cup-shaped, but often irregular, holdfasts that are reflective in situ. The coenenchyme is medium to light orange in color.

In addition to the collected specimen, we observed approximately 50 colonies in the immediate area with morphology that conformed to this same species. Colonies were mostly planar, with up to 45 branches emanating mostly from near the base, and were rarely branched to the 3rd order. The largest colonies are to 150 cm in width and at least 70 cm in height. The largest colonies have massive holdfasts (up to 13 cm in diameter) that were covered with coenenchyme and polyps (see photo G).

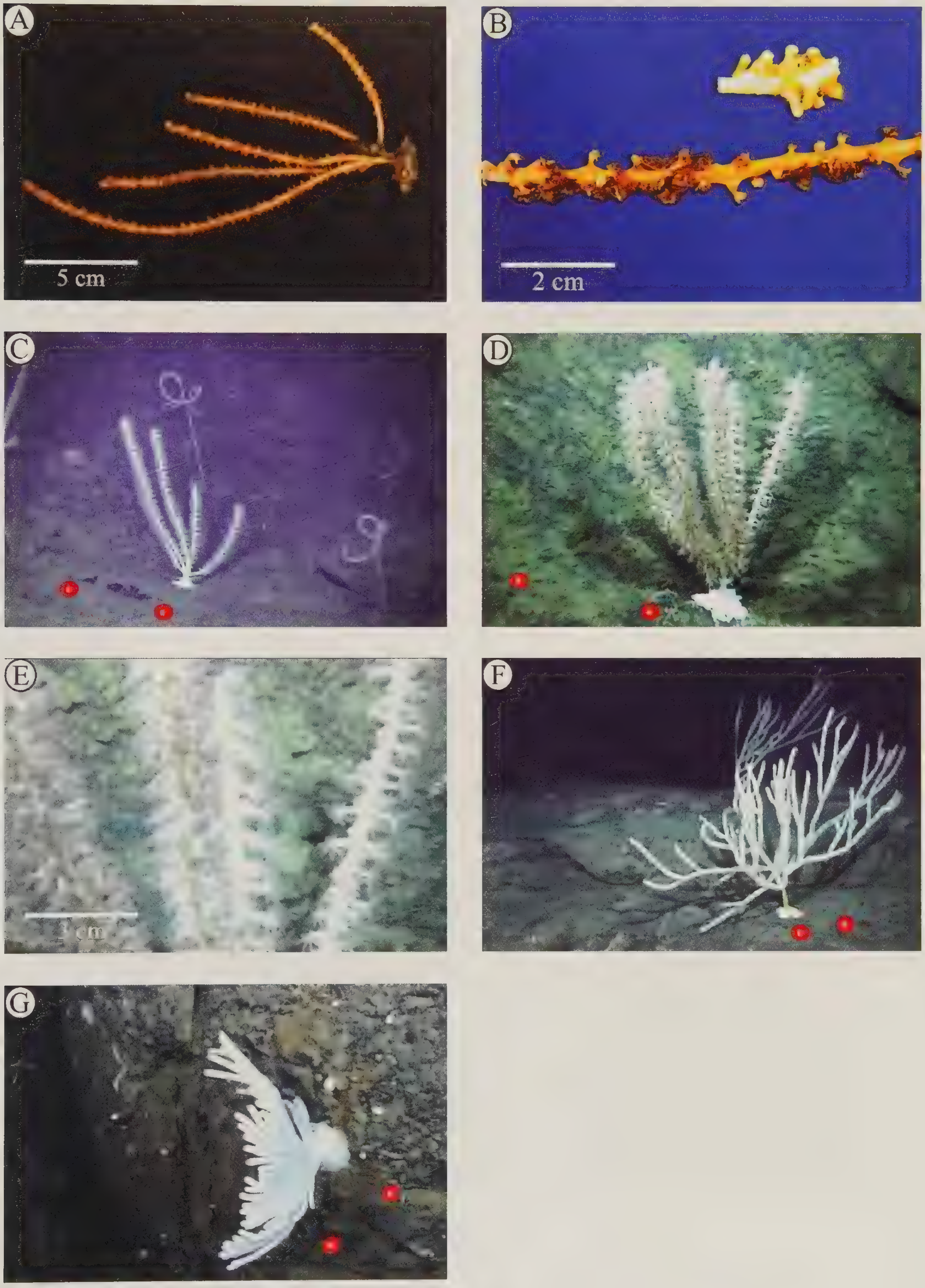
Remarks This genus was erected to accommodate a new species from New Caledonia, *Orstomisis crosnieri* Bayer, 1990, found at depths between 542 and 600 m. The Alaska specimen is currently queued for formal species description (Watling[12] and France[13]). The only other specimen assigned to the genus was recently collected from the Mid-Karin Ridge near Hawaii and was generically identified by S. D. Cairns as *Orstomisis*.

The skeleton (internodes) is composed almost entirely (98.2%) of high-magnesium calcite (8.0 mol% $MgCO_3$) with minute amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Rare. In Alaska – known only from a small area south of Amlia Island, central Aleutian Islands (Fig. 12-9). Elsewhere – unknown.

Habitat In Alaska – occurs singly or in small patches (up to 3 colonies/m^2) on siltstone, bedrock, and fractured bedrock (cobble) at depths between 2674 and 2826 m. Co-occurs with the the antipatharian *Trissopathes pseudotristicha*, and the octocorals *Radicipes stonei* and *Plumarella aleutiana* Cairns, 2011. Elsewhere – the Hawaiian specimen grew singly on basalt table rock at a depth of 2255 m.

Photos A) A fresh whole *Orstomisis* sp. colony (USNM 1484147/1659770) collected south of Amlia Island, central Aleutian Islands, at a depth of 2826 m. B) A close-up view of the same specimen in photo A showing the arrangement of the polyps. C) The same colony in photo A just before collection. D) An *Orstomisis* sp. colony photographed on the same submarine ridge at a depth of 2826 m. E) A close-up view of the same specimen in photo D. F) Two large *Orstomisis* sp. colonies photographed on the same submarine ridge as the specimens in photos C and E. G) An *Orstomisis* sp. colony photographed on the same submarine ridge as the specimens in photos C, E, and F. The distance between the red laser marks in photos C, D, F, and G is 20 cm.


A
5 cm
B
2 cm
C
D
E
2 cm
F
G

13. *Orstomisis* sp. (continued)

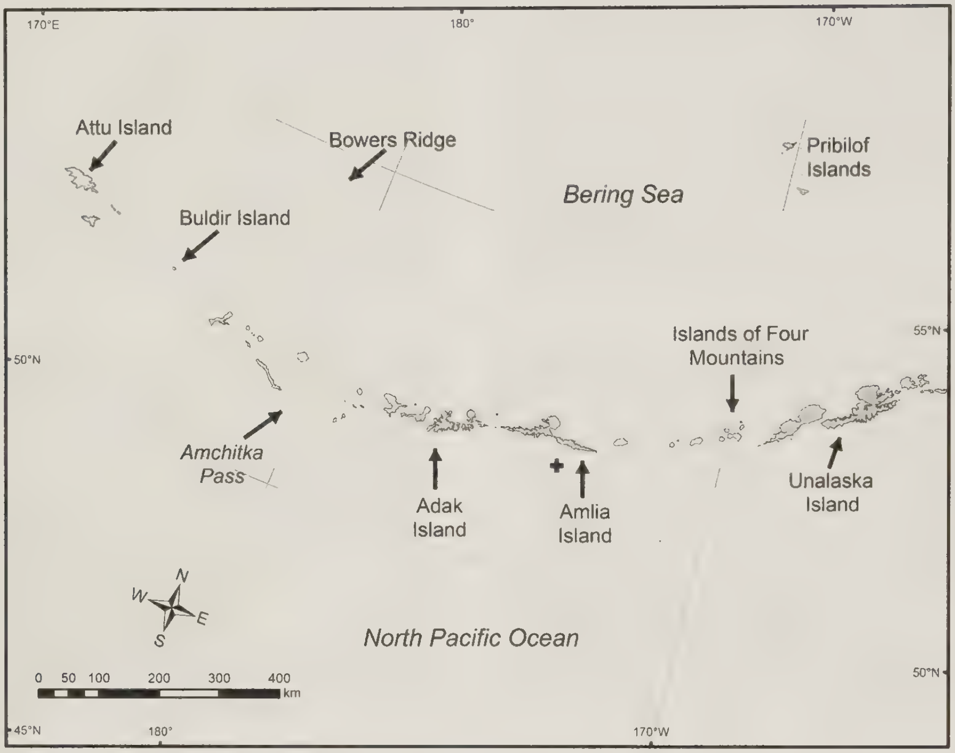

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amlia Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 12-9

A map of the Aleutian Islands showing the distribution of *Orstomisis* sp. (+) in Alaska waters.

CHAPTER 13

Family Primnoidae

Corals in the family Primnoidae are octocorals with a skeletal axis of solid, non-scleritic material and continuous calcium carbonate (Fig. 13-1). A cross-section of the axis shows undulating concentric layers of calcified material variably embedded in gorgonin (Fig. 13-1). Colonies are erect, typically branched, firmly attached to hard substrate with a robust calcareous holdfast, and sometimes referred to as gorgonians or sea fans. Polyps are monomorphic and non-retractile with calyces occurring in many forms and arrangements (McFadden et al., 2022).

Primnoids that occur in Alaska waters are colonial and ahermatypic. Some species attain very large size, are locally abundant, and play a major role in constructing important benthic habitats (Stone, 2006, 2014). Twenty-six species (plus one variant) of primnoids are known from Alaska waters. Twelve species appear to be endemic to the Aleutian Islands and four species (all *Narella*) appear to be endemic to seamounts in the Gulf of Alaska Seamount Province. One species ranges further to the east (Asia), three species range further to the south (including the variant), and two species range to both the east and south.

Primnoids are found in all regions of Alaska except the Arctic; none are found further north than Zhemchug Canyon in the eastern Bering Sea (Fig. 13-2). The records for most taxa represent the northernmost in the world. They are eurybathic fauna in Alaska occupying depths between 6 and 4633 m. All taxa are firmly attached or fixed and typically grow on bedrock, boulders, cobbles, pebbles, and occasionally on siltstone. *Plumarella* and *Callogorgia* spp. have been observed attached to hexactinellid sponge skeleton.

The current state of taxonomy for the group is excellent and there are no taxa with unresolved taxonomy. Nonetheless, specimens collected in Alaska should be properly preserved for taxonomic examination and

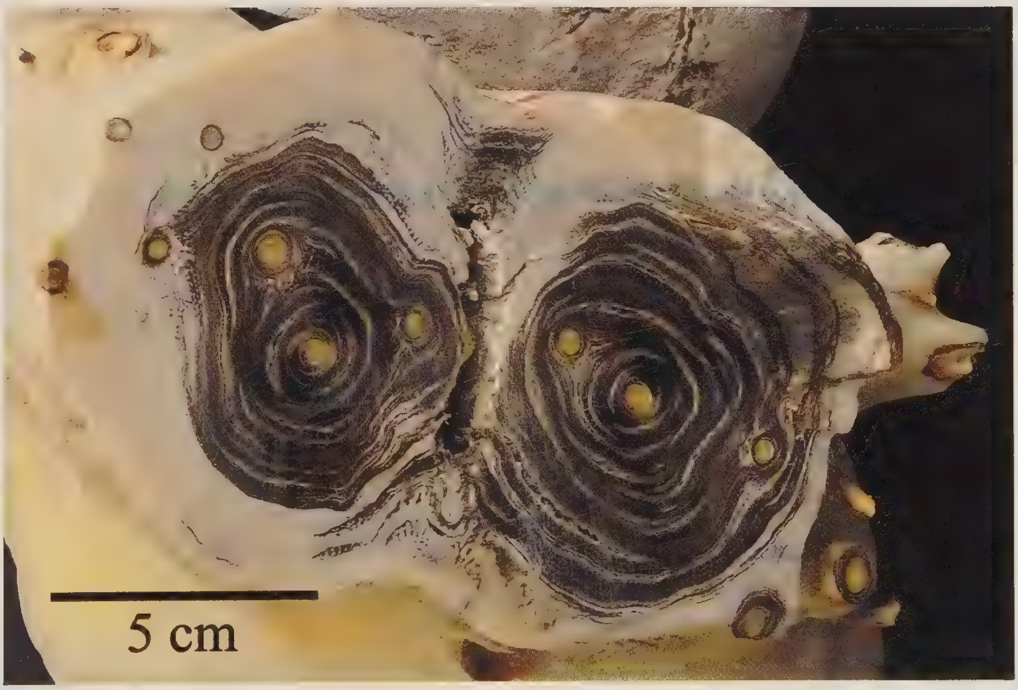


Figure 13-1

A cross-sectional view of a very large *Primnoa pacifica* specimen (two colonies grown together) collected in Dixon Entrance in the eastern Gulf of Alaska showing the heavily calcified solid axis composed of calcite and aragonite that is characteristic of the family Primnoidae.

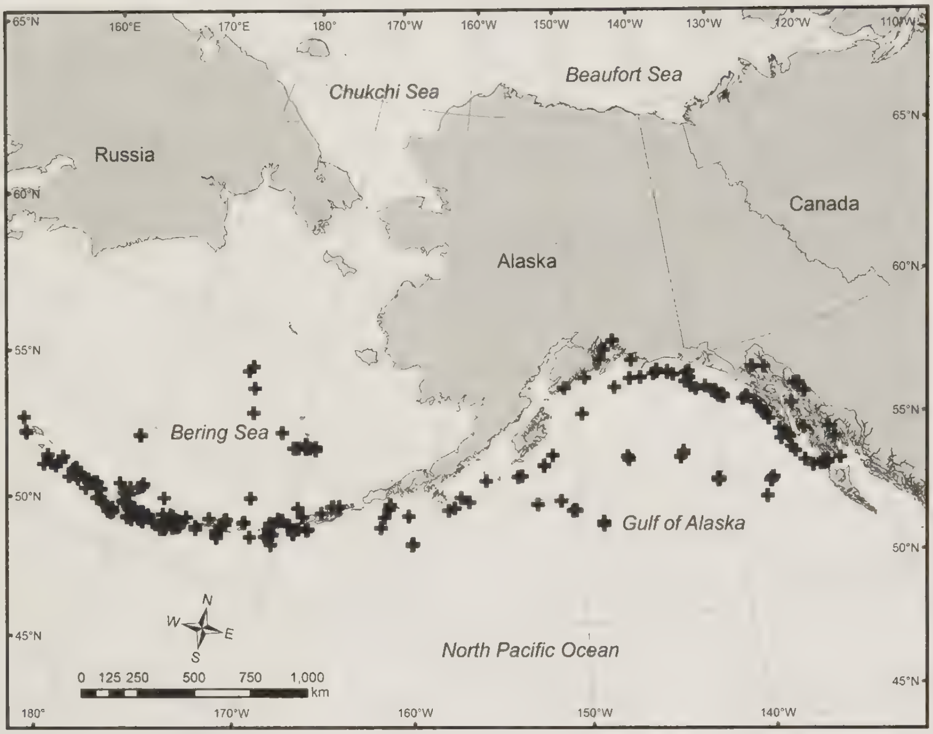

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
60°N
55°N
Bering Sea
50°N
Gulf of Alaska
45°N
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W

Figure 13-2

A map of the North Pacific Ocean showing the distribution of corals in the family Primnoidae (+) in Alaska waters.

zoogeographic study if suspected of being unknown or a bathymetric or geographic range extension. Conventional terminology is used to describe the various species (Bayer et al., 1983; Cairns, 2016).

Most taxa are generally not much larger than 30 cm in height or width but *Primnoa pacifica* attains great size: up to 5 m in both height and width in exceptional specimens. Most taxa are found either in low- or high-density patches, and these patches may provide important refuge and foraging habitat for juvenile fish and crab species (Stone, 2014; Stone et al., 2015b). Many species, particularly those in shallower water, host a diverse and abundant suite of fauna, particularly brittle stars (Ophiuroidae) that are often cryptically colored. Those species within the current range of fishing activities (approximately 1200 m depth) are often observed damaged or detached on the seafloor (Krieger, 2001; Stone, 2006, 2014; Stone et al., 2015b) and are common bycatch in fisheries stock assessment surveys (Heifetz, 2002).

1. *Arthrogorgia kinoshitai* Bayer, 1952

Description (Adapted from Cairns, 2011a and Bayer, 1952b) Colonies almost always branch in a uniplanar and irregularly dichotomous fashion, rarely monopodial in shallower water; the largest known colony is about 35 cm in height. Polyps are arranged in whorls of six to nine with their mouths directed downward. Polyps are 3.0–3.5 mm in length with about 2.5 polyps/cm branch length. The axis is light brown to golden brown; color of the coenenchyme is very light orange to orange in life and yellowish-orange when dried.

Each polyp is protected by eight opercular scales; one pair of buccal and basal scales; zero to three rows of transverse, curved infrabasal scales; and four to six pairs of adaxial scales. The distal edge of the buccal scales are rounded and elongate, forming a cowl around the opercular scales; the distal edge of each basal scale bears a long, longitudinally ridged spine. Coenenchymal scales are stellate to irregular in shape.

Remarks *Arthrogorgia* is quite similar to *Paracalyptrophora* but differs in having multiple transverse rows of infrabasal scales. Three of the four known species of *Arthrogorgia* occur in the Aleutian Islands (Cairns, 2011a). *Arthrogorgia kinoshitai* is quite similar to *Arthrogorgia utinomii* Bayer, 1996, but differs in having longer buccal scales that form a cowl around the operculum, and in having fewer or no infrabasal scales (Cairns, 2011a).

This species hosts a rich suite of associated fauna including pleustid amphipods and antarcturid isopods (Watling and Stone[7]). The coenenchymal sclerites are composed of high-magnesium calcite (8.3 mol% $MgCO_3$) whereas the skeletal axis is composed entirely of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon (Fig. 13-3). In Alaska – endemic to the Aleutian Islands (Tanaga Pass to west of Attu Island). Elsewhere – not reported.

Habitat Typically found singly but occasionally in small patches, attached to cobbles and large pebbles, in areas of moderate current, and at depths between 150 and 1309 m.

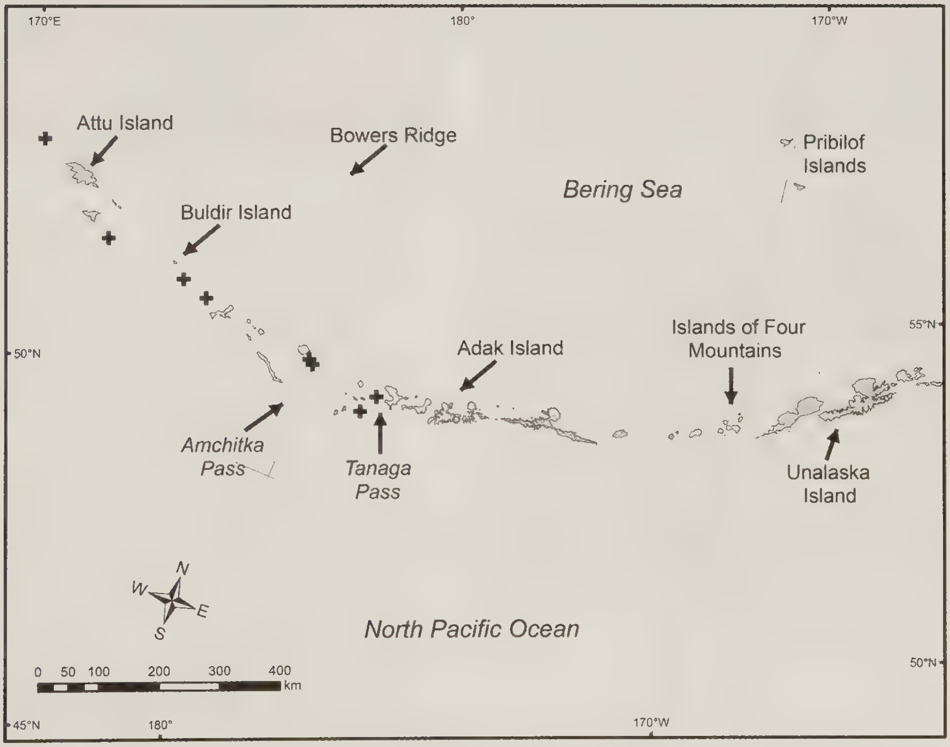
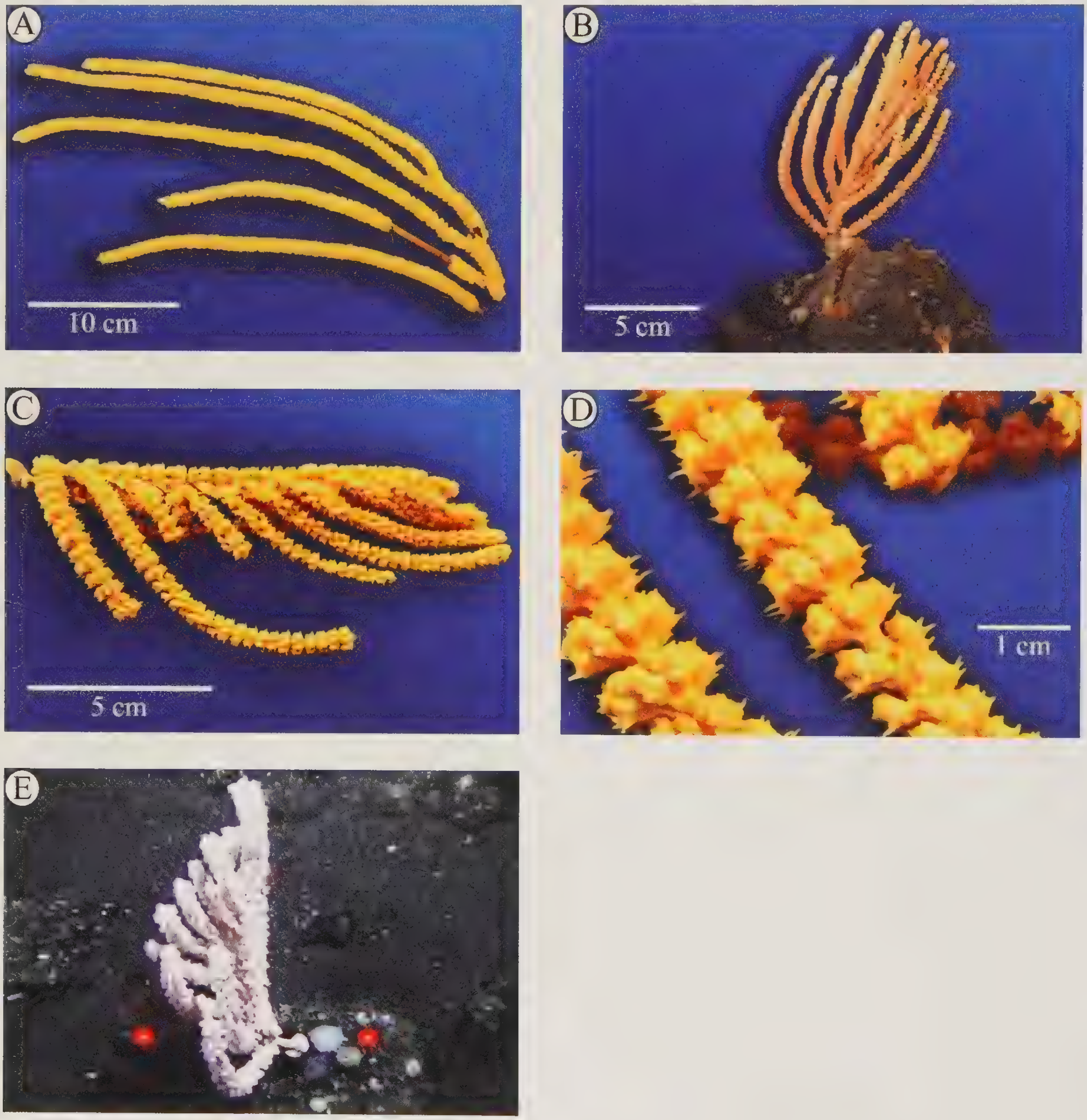


Figure 13-3

A map of the Aleutian Islands showing the distribution of *Arthrogorgia kinoshitai* (**+**) in Alaska waters.



Photos A) Dried branches of an *A. kinoshitai* colony (USNM 1481912) collected on Amchixtam Chaxsxii, central Aleutian Islands, at a depth of 150 m. B) A dried whole *A. kinoshitai* colony (USNM 1115594) collected in Amchitka Pass, central Aleutian Islands, at a depth of 1307 m. C) A lateral view of the same specimen in photo B. D) A close-up view of the same specimen in photo B. E) The same colony in photo B prior to collection. The distance between the red laser marks is 10 cm.

2. *Arthrogorgia otsukai* Bayer, 1952

Description (Adapted from Cairns, 2011a and Bayer, 1952b) Colonies have uniplanar, equal, and dichotomous branching; the largest known colony is 20 cm in height. Polyps are arranged in whorls of five to seven with their mouths directed downward. Polyps are 2.30–2.75 mm in length with 3.5–4.5 polyps/cm branch length. The axis is golden brown; the color of the coenenchyme is light orange to orange in life and yellowish-orange when dried.

Each polyp is protected by eight opercular scales; one pair each of buccal and basal scales; four or five transverse rows of small, curved infrabasal scales; and two short rows (four to six scales in each row) of adaxial scales. The distal edges of the buccal and basal scales are lobate. The coenenchymal scales are thin, flat, polygonal, and up to 0.5 mm in width.

Remarks *Arthrogorgia otsukai* differs from other species in the genus in lacking spines on its basal scales.

Much uncertainty underlies the type locality of the holotype (USNM 49979) described by Bayer (1952b), who provided only that the specimen was collected in 1906 by the U.S. Fisheries Steamer *Albatross* "between Bowers Bank, Bering Sea and the codfish banks off the mouth of the Aangan River, Kamchatka." Later Bayer (1996) indicates that the "exact station data were obliterated." Cairns (2011a) further indicates that the collection lot consists of 16 colonies from which Bayer (1952b) did not specifically designate a holotype, hence the lot consists of 16 syntypes, but again with no additional station data.

The location description provided is quite confounded since the Aangan River is on the west side of the Kamchatka Peninsula and drains into the Sea of Okhotsk and is not even in the same sea as Bowers Bank (eastern Bering Sea, U.S.). Furthermore, we can find no formal reference to "codfish banks" aside from the one written in the U.S. Fisheries Steamer *Albatross* expedition notes regarding the 1906 collections. The Smithsonian Museum of Natural History database currently lists the specimen as being collected on 21 June 1906 at a depth of 46 m, which corresponds to the date and depth for U.S. Fisheries Steamer *Albatross* station 4798 near the mouth of the Aangan River in the Sea of Okhotsk. The depth recorded at that station is much too shallow for the species however. Of the seven stations (4793–4799) surveyed "off the mouth of the Aangan River," station 4797 (52°37.30′N, 158°50.00′E) with a depth of 1247 m (compared to 46–126 m for the other six stations) is most likely the actual location of the type locality. We suggest that the specimen was indeed collected at station 4797 but not retrieved from the trawl gear until after station 4798 was surveyed the next day.

This species hosts ophiuroids. The coenenchymal scales are composed of high-magnesium calcite (7.8 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Rare. In Alaska – known only from two locations (south of Tanaga Island and southern Amchitka Pass) in the central Aleutian Islands (Fig. 13-4) but fairly abundant at those locations. Elsewhere – Sea of Okhotsk, Russia.

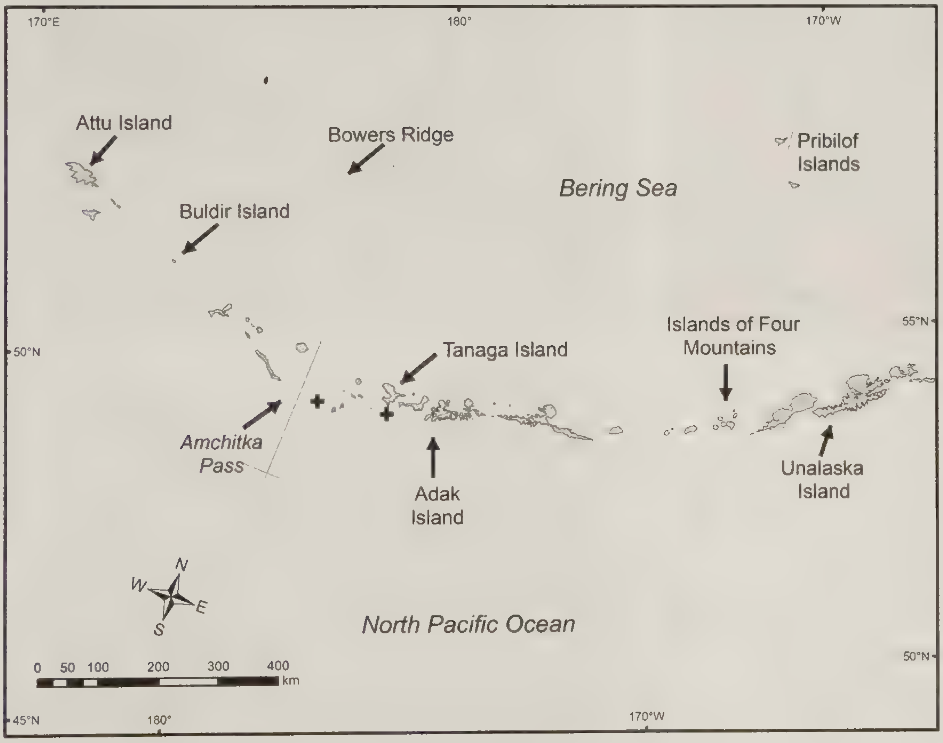
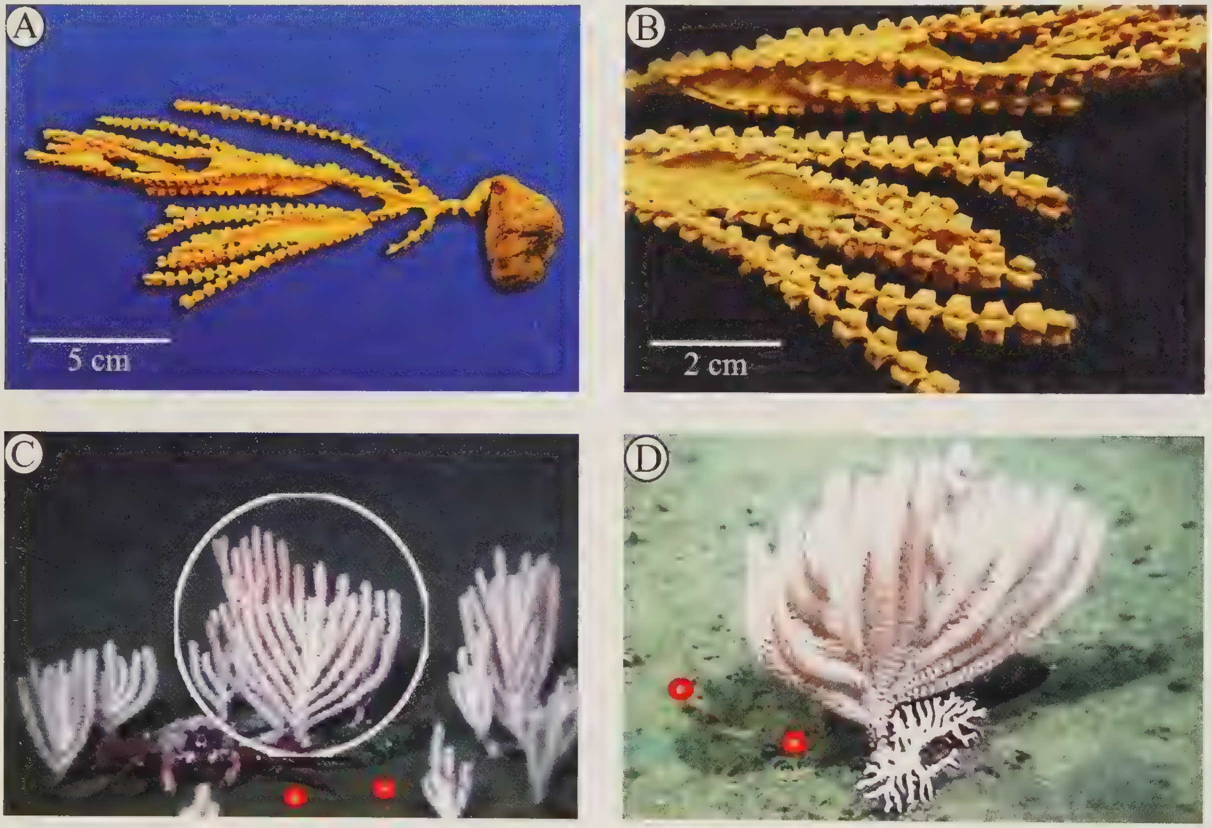


Figure 13-4

A map of the Aleutian Islands showing the distribution of *Arthrogorgia otsukai* (+) in Alaska waters.

Habitat In Alaska – typically found in small patches but occasionally singly, on hard rock including cobbles and siltstone, in areas of moderate current, and at depths between 1332 and 1348 m. Elsewhere – found at a depth of 1247 m.

Photos A) A dried whole *A. otsukai* colony (USNM 1115597) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 1348 m, showing a unique coenenchymal webbing between its branches. B) A close-up view of the same specimen in photo A. C) A patch of *A. otsukai* in southern Amchitka Pass at a depth of 1349 m. Colonies (USNM 1115597 and 115595) are within the white circle. A Verrill's king crab (*Paralomis verrilli*) takes shelter among the corals. D) An *A. otsukai* colony observed in the same patch in southern Amchitka Pass at a depth of 1359 m. The distance between the red laser marks in photos C and D is 10 cm.



3. *Arthrogorgia utinomii* Bayer, 1996

Description (Adapted from Bayer, 1996 and Cairns, 2011a) Colonies branch in an equal and dichotomous fashion; the largest known colony is 40 cm in height and 25 cm in width. Polyps are arranged in whorls of 7–10 with their mouths directed downward. Polyps are 3.0–3.5 mm in length with 2.5–3.0 polyps/cm branch length. The axis is golden to dark brown; the coenenchyme is pinkish orange to light orange in life and yellowish-orange when dried.

Each polyp is protected by eight opercular scales; one pair each of buccal and basal scales; two to four rows of transverse, curved infrabasal scales; one pair of relatively large adaxial scales; and smaller adaxial scales proximal to those. The distal edge of the buccal scales is rounded, but the distal edge of each basal scale bears a long, longitudinally ridged spine. Coenenchymal scales are elongate, irregularly shaped, and up to 0.65 mm in length.

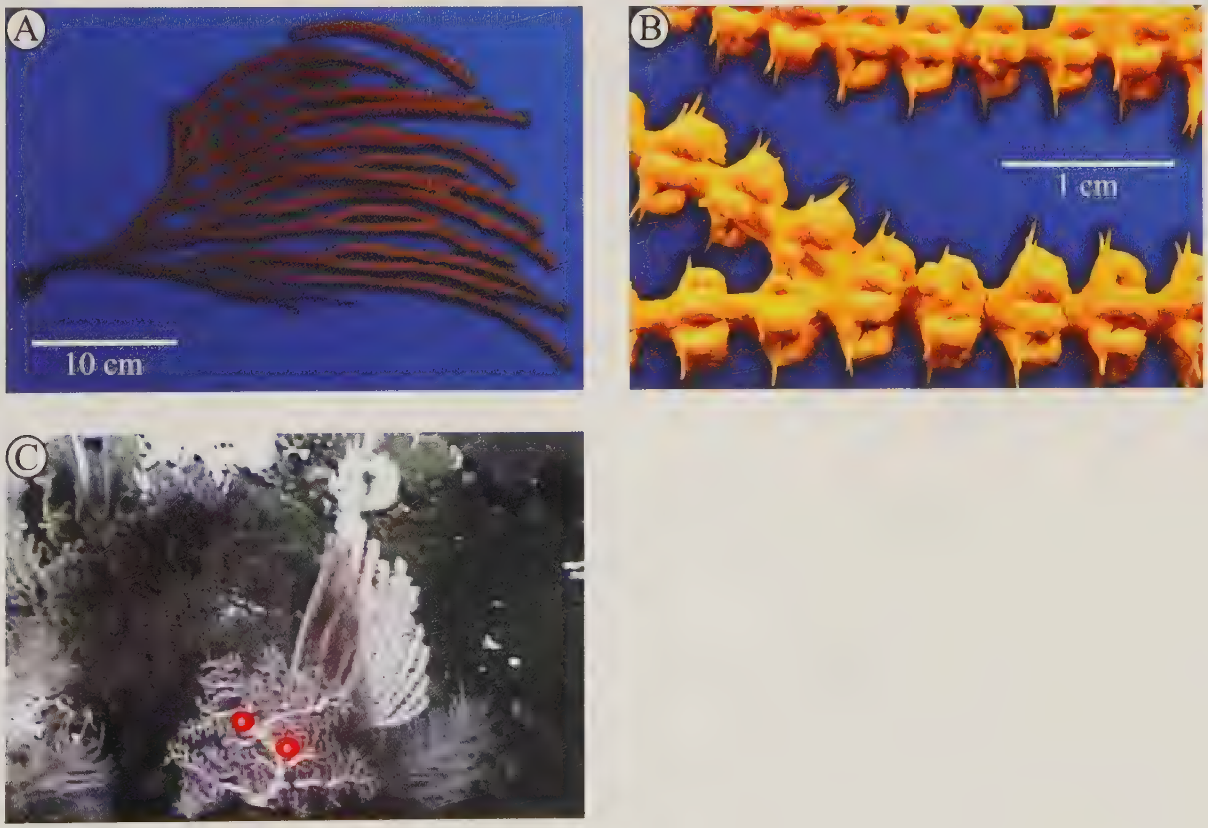
Remarks *Arthrogorgia utinomii* is very similar to *A. kinoshitai* and is compared to that species (see Remarks on page 235).

This species hosts ophiuroids. The coenenchymal sclerites are composed principally of aragonite (67%), with the remainder high-magnesium calcite (8.8 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon (Fig. 13-5). In Alaska – endemic to the Aleutian Islands south of Yunaska Island to southwest of Attu Island. Elsewhere – not reported.

Habitat Typically found in small patches but occasionally singly, on hard rock including cobbles, in areas of moderate current, and at depths between 163 and 882 m.

Photos A) A fresh whole *A. utinomii* colony (USNM 1115598) collected in northern Amchitka Pass, central Aleutian Islands, at a depth of 712 m. B) A close-up view of the same specimen in photo A, dried. C) The same colony in photo A just prior to collection. The distance between the red laser marks is 10 cm.



3. *Arthrogorgia utinomii* Bayer, 1996 (continued)

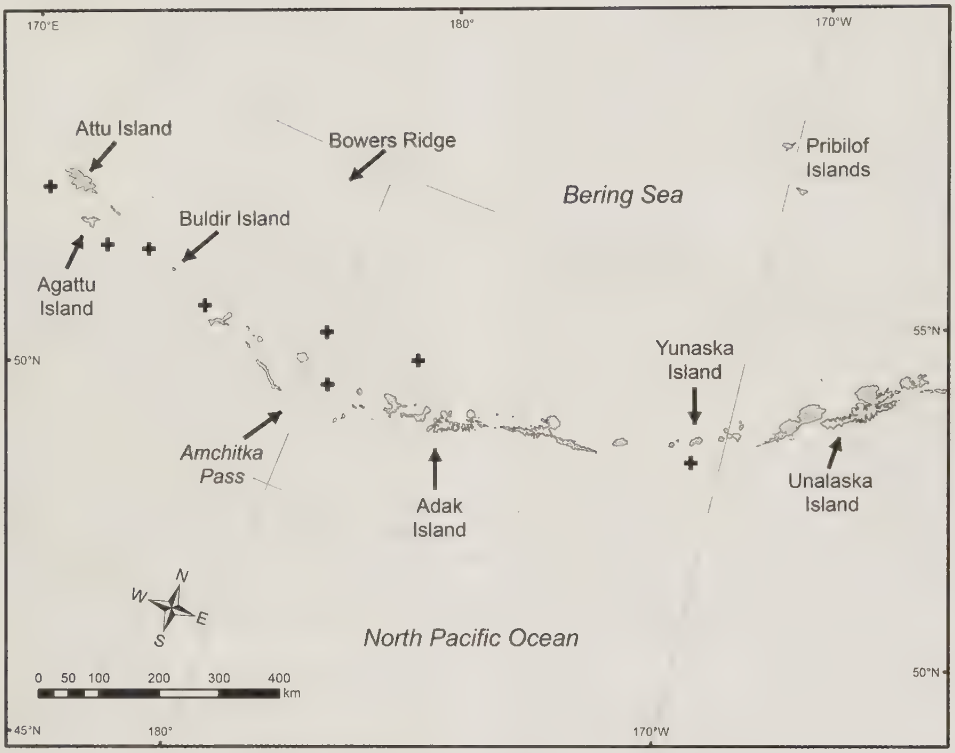

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Agattu Island
55°N
50°N
Yunaska Island
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-5

A map of the Aleutian Islands showing the distribution of *Arthrogorgia utinomii* (+) in Alaska waters.

4. *Callogorgia compressa* (Verrill, 1865)

Description (Adapted from Cairns, 2011a) Colonies branch in a uniplanar, equal, and dichotomous fashion; the largest known colony is 80 cm in height and 50 cm in width. Colonies may have more than 100 branch tips. Polyps face upward and are arranged in whorls of 8–12 on distal branches, but up to 25 on larger-diameter branches. Polyps are 1.6–2.0 mm in length with 4–6 whorls/cm branch length. The holdfasts are covered with coenenchyme and strongly attached to the substrate. The axis is metallic bronze; the coenenchyme is orange to light orange in life and a paler yellowish-orange when dried.

Each polyp is protected by eight opercular scales and eight longitudinal rows of body wall scales; the sclerite formula is 7–10: 5–7, 2–3: 1. Body wall and opercular scales are covered with coarse, longitudinally aligned tubercles. The coenenchymal sclerites consist of closely fitted polygonal plates and numerous tuberculate spheroids.

Remarks Until recently this species was placed in the genus *Fanellia* because of its coarse tuberculate body wall scales, but it has since been transferred to *Callogorgia* based on molecular evidence (Cairns and Wirshing, 2018). This species is compared to *Callogorgia fraseri* (Hickson, 1915) in the account of that species.

Callogorgia compressa colonies are often heavily populated with ophiuroids (>100/colony; see photos C and D on next page). Other associated fauna include the bivalve *Acesta* sp. that attaches to exposed areas of the axial skeleton (Watling and Stone[7]).

Distribution Locally common. In Alaska – endemic to the Aleutian Islands from near Umnak Island to west of Attu Island (Fig. 13-6). Elsewhere – not reported.

Habitat Typically found in small patches, rarely singly, on hard rock (cobbles and pebbles), in areas of moderate current, and at depths between 82 and 1341 m.

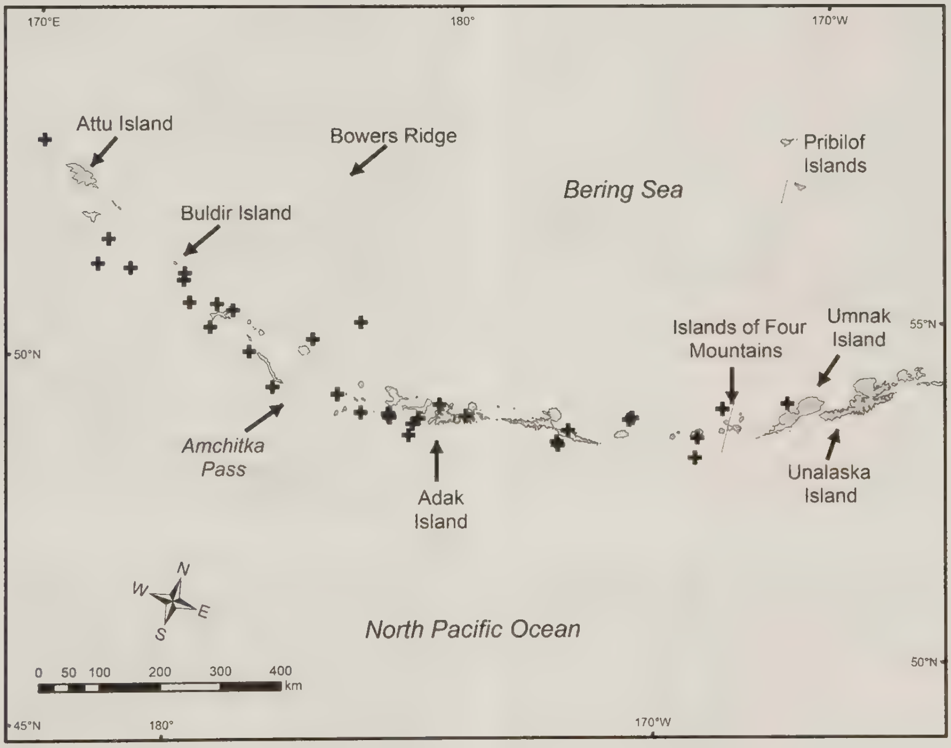
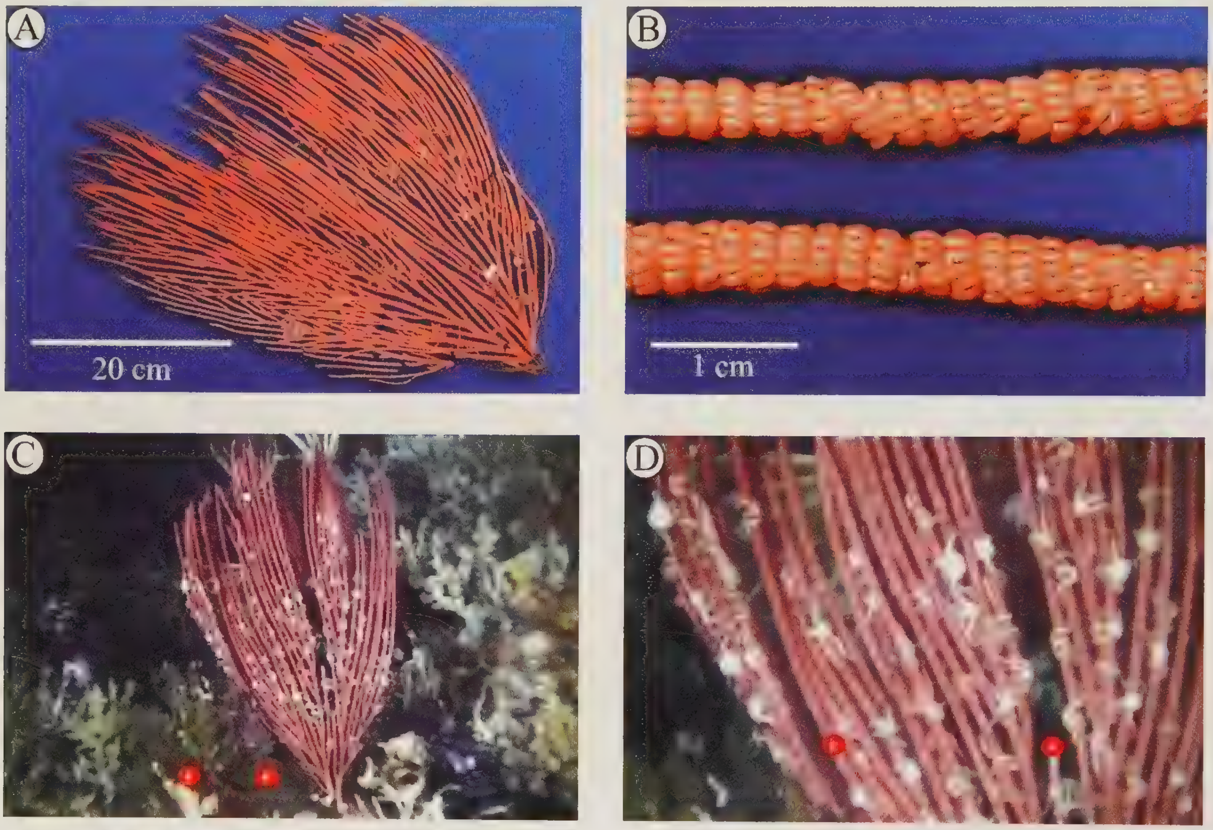

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
55°N
50°N
Islands of Four Mountains
Umnak Island
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-6

A map of the Aleutian Islands showing the distribution of *Callogorgia compressa* (+) in Alaska waters.

Photos A) A fresh whole (except the holdfast) *C. compressa* colony (USNM 1123883) collected on the Adak Canyon shelf, central Aleutian Islands, at a depth of 155 m. B) A close-up view of a *C. compressa* specimen (USNM 1411817) collected near the Delarof Islands, central Aleutian Islands, at a depth of 100 m. C) A *C. compressa* colony harboring many ophiuroids, photographed northwest of Adak Island at a depth of 210 m. D) A close-up view of the same colony in photo C. The distance between the red laser marks in photos C and D is 10 cm.



5. *Callogorgia fraseri* (Hickson, 1915)

Description (Adapted from Cairns, 2011a) Colonies branch in a uniplanar, alternate pinnate fashion; the largest known colony is 55 cm in height and 35 cm in width. Colonies have up to 100 branch tips. Polyps face upward and are arranged in whorls of five to eight on distal branches, but up to 12 on larger-diameter branches. Polyps are 1.1–1.5 mm in length with 6–7 whorls/cm branch length. The holdfasts are covered with coenenchyme and strongly attached to the substrate. The axis is brownish-yellow; the coenenchyme is orange to light orange in life and a paler yellowish-orange when dried.

Each polyp is protected by eight opercular scales and eight longitudinal rows of body wall scales; the sclerite formula is 7–8: 2–3: 1: 0–1. The opercular and body wall scales are covered with coarse, longitudinally aligned tubercles. The coenenchymal sclerites consist of tuberculate spheroids.

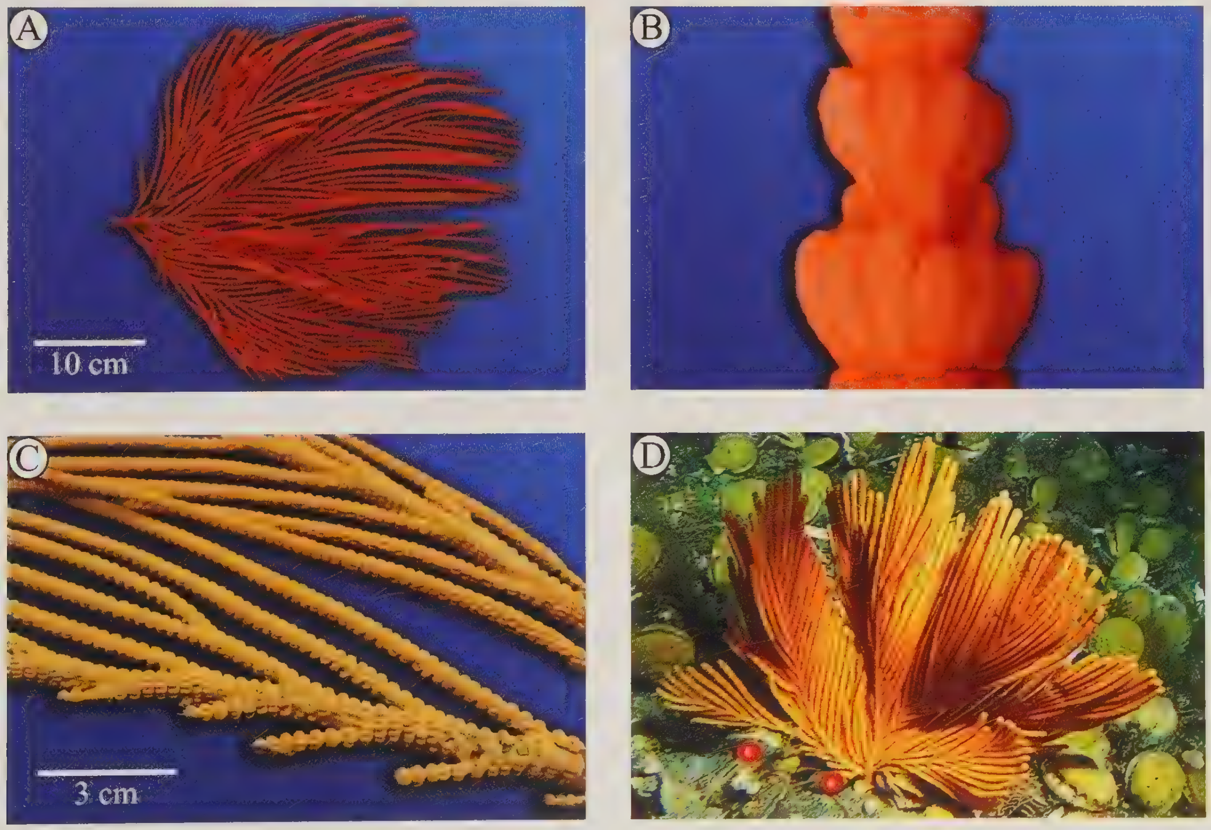
Remarks This species differs from *C. compressa* by having a pinnate colony, fewer body wall scales, more whorls per centimeter, and smaller polyps.

This species is often heavily populated with ophiuroids (>100 per specimen). The skeletal axis and coenenchymal sclerites are composed of high-magnesium calcite (12.4 and 8.7 mol% $MgCO_3$, respectively; senior author and S. D. Cairns, unpubl. data).

Distribution Locally common. In Alaska – from Albatross Bank in the western Gulf of Alaska to Amchitka Pass in the central Aleutian Islands (Fig. 13-7). Elsewhere – not reported.

Habitat Typically found in small patches, rarely singly, on hard rock (cobbles and pebbles), in areas of moderate current, and at depths between 52 and 1341 m.

Photos A) A fresh whole (except the holdfast) *C. fraseri* colony (USNM 1123890) collected near Little Tanaga Island, central Aleutian Islands, at a depth of 98 m. B) A close-up view of the same specimen in photo A. C) A dried branch of a *C. fraseri* colony (USNM 1123891) collected south of Adak Island, central Aleutian Islands, at a depth of 100 m. D) A *C. fraseri* colony (USNM 1123890) prior to collection. The distance between the red laser marks is 10 cm.



5. *Callogorgia fraseri* (Hickson, 1915) (continued)

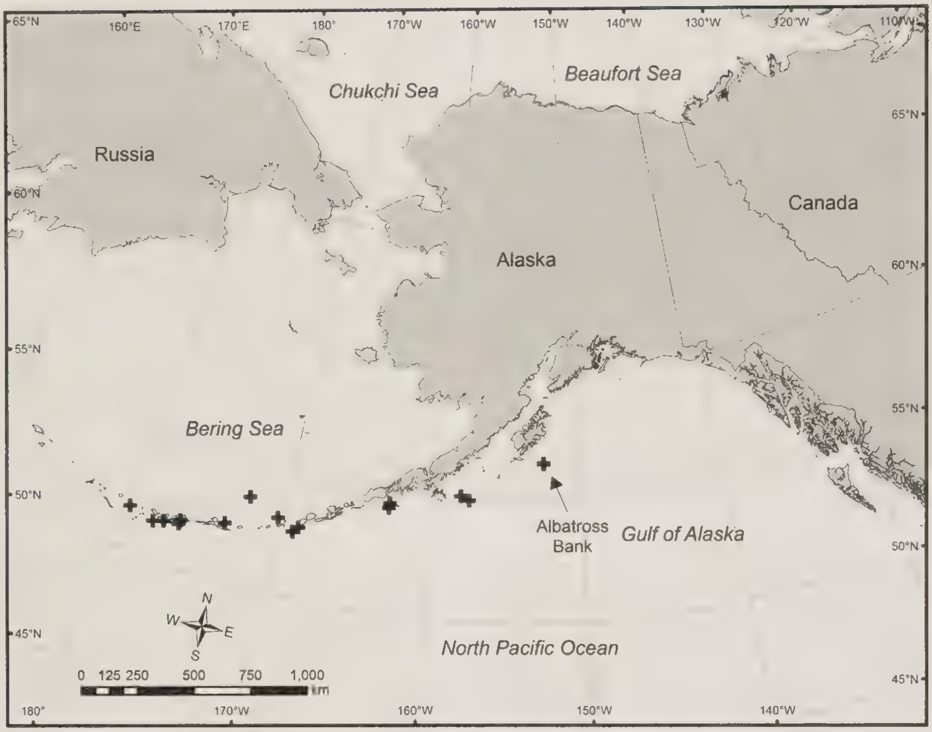

Chukchi Sea
Beaufort Sea
Russia
Alaska
Canada
Bering Sea
Albatross Bank
Gulf of Alaska
North Pacific Ocean
0 125 250 500 750 1,000 km
N
W
E
S
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 13-7

A map of the North Pacific Ocean showing the distribution of *Callogorgia fraseri* (+) in Alaska waters.

6. *Calyptrophora laevispinosa* Cairns, 2007

Description (Adapted from Cairns, 2007, 2011a) Colonies branch usually in a uniplanar but occasionally bushy, even scraggly manner (see photo F on next page). They are dichotomously branched with a slight tendency to be pinnate. The largest known colony is 70 cm in height and 59 cm in width. Large colonies have up to 80–100 branch tips and prominent, often irregular holdfasts. The axis is golden brown; the coenenchyme is very light orange to white in life and when dried.

The polyps face upwards and are arranged in whorls of three or four. Polyps are 1.5–2.0 mm in length with 3.3–4.0 whorls/cm branch length. Each polyp is protected by eight opercular scales, one basal and one buccal scale, and two pairs of slender, curved infrabasal scales. Each basal scale bears two long and slender, smooth (not ridged) spines; each buccal scale bears four to six slender, non-ridged spines. The coenenchymal scales are elongate (up to 1.3 mm in length), elliptical, and sparsely granular.

Remarks *Calyptrophora laevispinosa* is the only *Calyptrophora* species known from Alaska waters and one of the deepest dwelling among the 27 extant species known worldwide (Cairns, 2018). Some colonies observed in situ appear to have been preyed upon by an unknown predator (likely a sea star).

Small colonies are morphologically similar (e.g., branching pattern) to *Keratoisis* sp. D with which it co-occurs, but the latter species is quite fragile whereas the former is very difficult to tear upon collection.

Distribution Uncommon. In Alaska – known only from seamounts in the Gulf of Alaska Seamount Province (Welker, Pratt, Giacomini, Patton, and Derickson Seamounts). Also observed on video footage collected on Dickens and Murray Seamounts (Fig. 13-8). This species has not been documented from the continental slope or the Aleutian Islands. Elsewhere – only documented on Gorda Flow on the continental slope off Washington.

Habitat In Alaska – typically found singly but occasionally in small, scattered patches on bedrock, fractured bedrock, boulders and cobbles, in areas of moderate current, and at depths between 1754 and 3531 m. Elsewhere – at a depth of 3107 m.

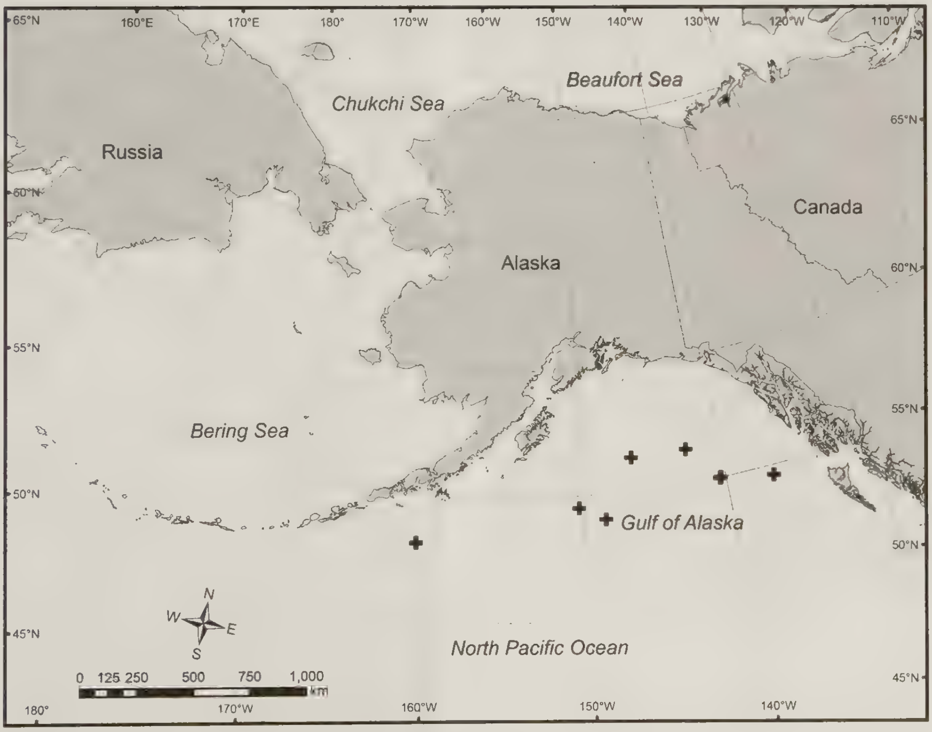
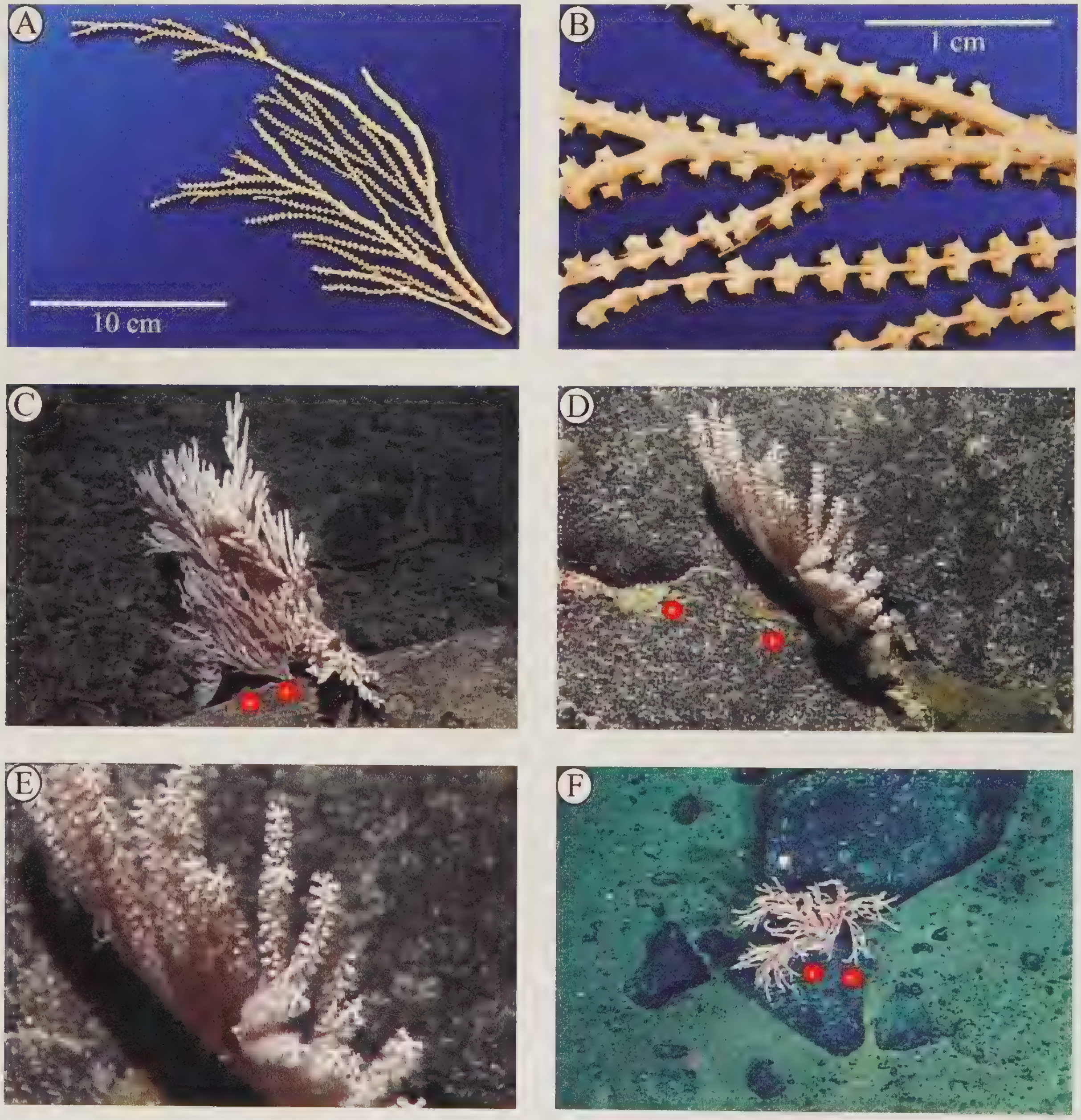


Figure 13-8

A map of the North Pacific Ocean showing the distribution of *Calyptrophora laevispinosa* (+) in Alaska waters.

Photos A) A dried large branch complex of *C. laevispinosa* (USNM 1081196) collected on Derickson Seamount at a depth of 3444 m. B) A close-up view of the same specimen in photo A. C) A *C. laevispinosa* colony (USNM 1075473) collected on Pratt Seamount at a depth of 2776 m. D) A *C. laevispinosa* colony (USNM 1075474) collected on Pratt Seamount at a depth of 2676 m. E) A close-up view of the same colony in photo D. F) A *C. laevispinosa* colony (USNM 1082617) collected on Patton Seamount at a depth of 1993 m. The distance between the red laser marks in photos C, D, and F is 10 cm.



7. *Narella abyssalis* Cairns and Baco, 2007

Description (Adapted from Cairns and Baco, 2007) The holotype colony has uniplanar, sparse, dichotomous branching and is 33 cm in height and 42 cm in width. The polyps face downward and are arranged in whorls of two to four. Polyps are 1.9–2.4 mm in length with 3 whorls/cm branch length. The axis is golden brown; the coenenchyme is very light orange in life and in ethanol.

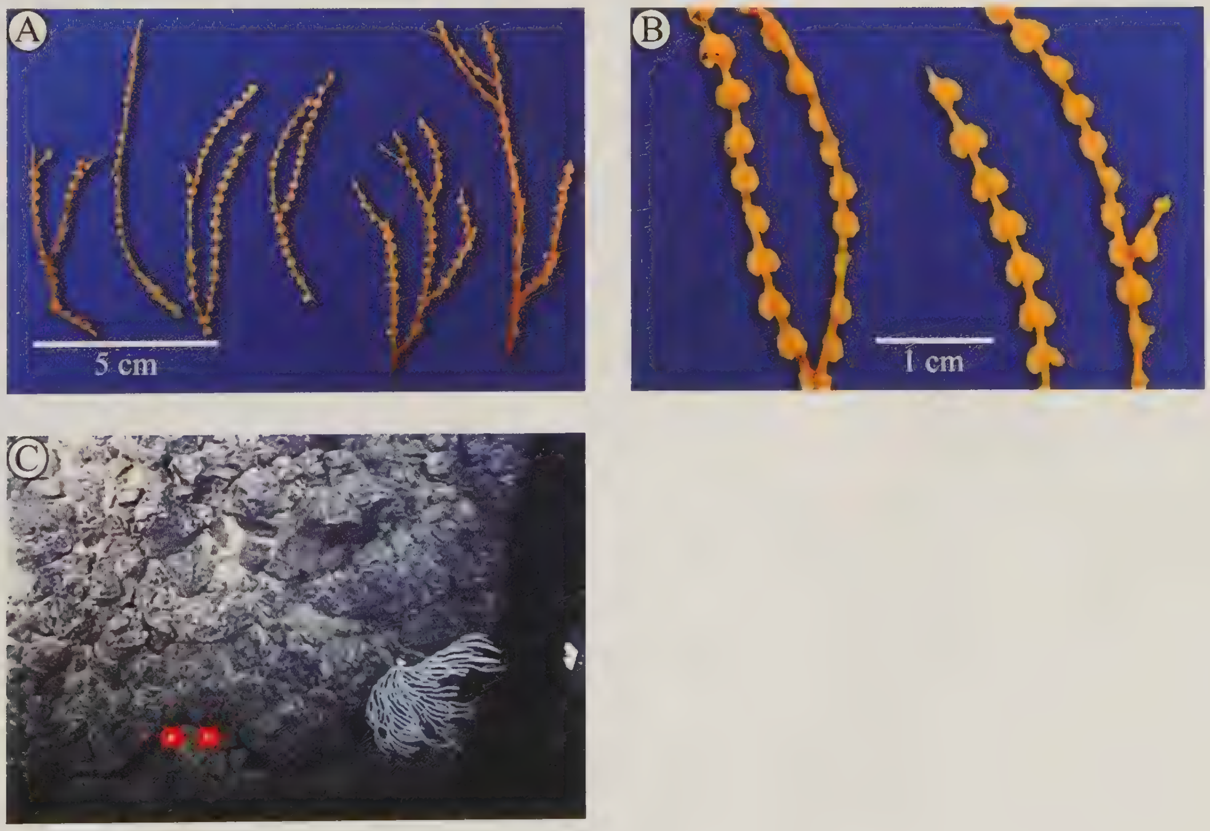
Each polyp is protected by eight opercular scales, four pairs of abaxial body wall scales (basals, two pairs of medials, and buccals), and one or two pairs of small, elliptical adaxial body wall scales. The dorsolateral edges of all body wall scales are prominently ridged. The coenenchymal scales are fusiform, up to 1.3 mm in length, and each bears a tall medial ridge (i.e., a sail scale).

Remarks A tabular key was published (Cairns and Baco, 2007) comparing the five *Narella* species known from Alaska, and tabular and dichotomous keys have recently been published for all 50 known species in the genus (Cairns and Taylor, 2019). *Narella abyssalis* differs from all other Alaska species by having four (not three) pairs of body wall scales. It is the deepest dwelling species in the genus.

Distribution Rare. In Alaska – known only from the holotype collected on Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 13-9). Elsewhere – not reported.

Habitat The holotype was collected at a depth of 4594 m but other specimens observed on video footage at depths between 4559 and 4633 m appeared to be this species (the other four species are unknown at these depths). Colonies were always observed singly or in small patches on bedrock (basalt) and fractured bedrock.

Photos A) Preserved (in ethanol) branches of a *N. abyssalis* holotype (USNM 1080450) collected on Derickson Seamount at a depth of 4594 m. B) A close-up view of the same specimen in photo A. C) A suspected *N. abyssalis* colony on Derickson Seamount at a depth of 4633 m. The distance between the red laser marks is 10 cm.



7. *Narella abyssalis* Cairns and Baco, 2007 (continued)

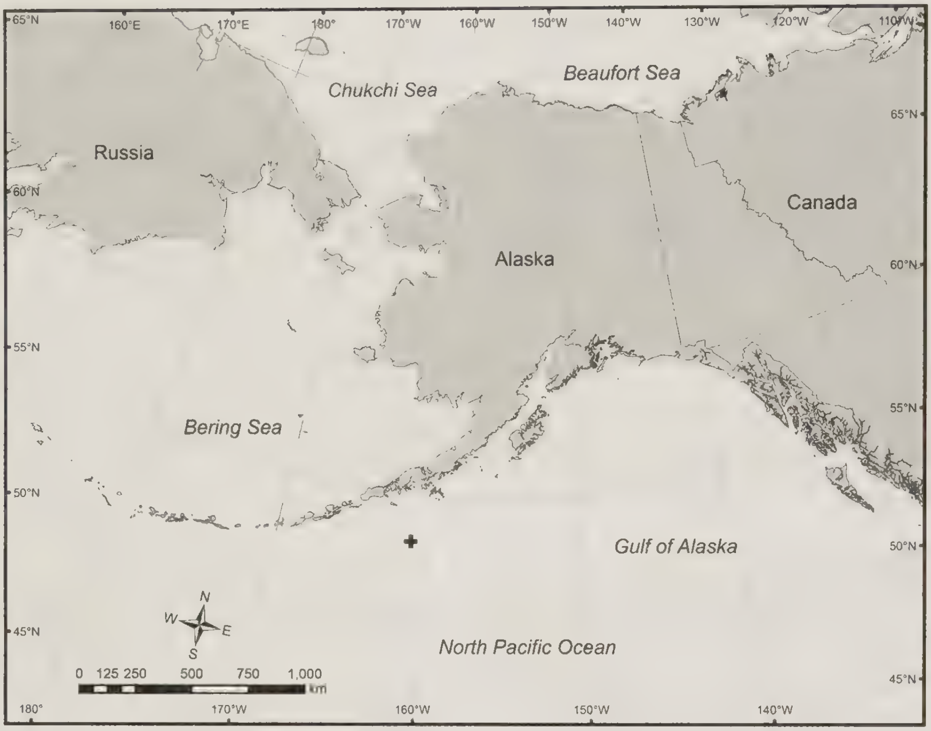

Chukchi Sea
Beaufort Sea
Russia
Alaska
Canada
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
65°N
60°N
55°N
50°N
45°N

Figure 13-9

A map of the North Pacific Ocean showing the distribution of *Narella abyssalis* (+) in Alaska waters.

8. *Narella alaskensis* Cairns and Baco, 2007

Description (Adapted from Cairns and Baco, 2007) Colonies branch in a uniplanar, sparsely dichotomous fashion, with up to 30 branch tips in large specimens. The largest colony has dimensions of 41 cm in height and 25 cm in width. Colonies appear to be relatively flexible and wave gently in the current in situ. All polyps face downward and are arranged in whorls of seven to nine on large-diameter branches and whorls of four or five on small-diameter branches. Polyps are 2.7–3.2 mm in length with 3.5 whorls/cm branch length. Large specimens have prominent, stout, irregularly shaped holdfasts without coenenchyme. The axis is golden brown; the coenenchyme is very light orange to white in life and light orange in ethanol.

Each polyp is protected by eight opercular scales; a pair of basal, medial, and buccal body wall scales; and one or two pairs of small oval adaxial body wall scales. The abaxial body wall scales are quite flared. The dorsolateral edge of basal and medial scales sometimes bears a low ridge; the buccal body wall scales have no ridges. The distal edge of each basal scale bears a projecting broad, blunt spine or spur. The coenenchymal scales are fusiform, up to 0.9 mm in length, and bear a tall medial ridge (i.e., a sail scale).

Remarks *Narella alaskensis* differs from all other Alaska species by having basal scale spines (Cairns and Baco, 2007). Colonies are occasionally overgrown with small actiniarians (see photo D on next page) and often host large numbers of ophiuroids.

Distribution Common (Fig. 13-10). In Alaska – grows in low-density patches on seamounts in the Gulf of Alaska Seamount Province (Dickens, Densen, Welker, Murray, and Chirikof Seamounts). Particularly abundant on Murray Seamount (up to 5 colonies/m^2) where it is the dominant coral in its depth range. This species has not been documented on the continental slope or from the Aleutian Islands. Elsewhere – only known from San Marcos Seamount off central California.

Habitat In Alaska – observed on video footage singly or in small patches on bedrock (basalt) and fractured

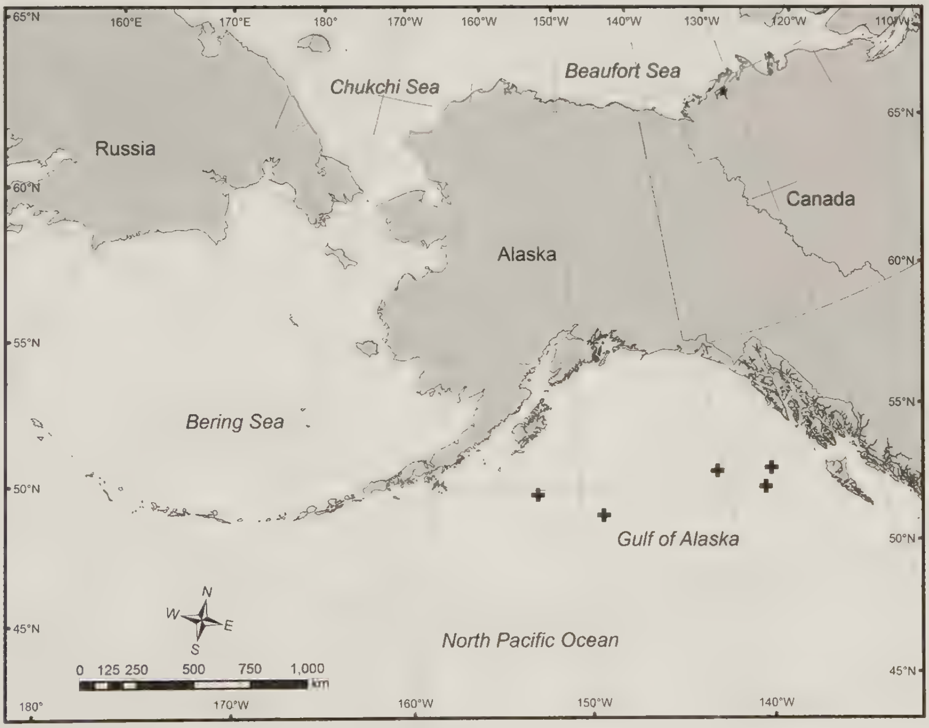
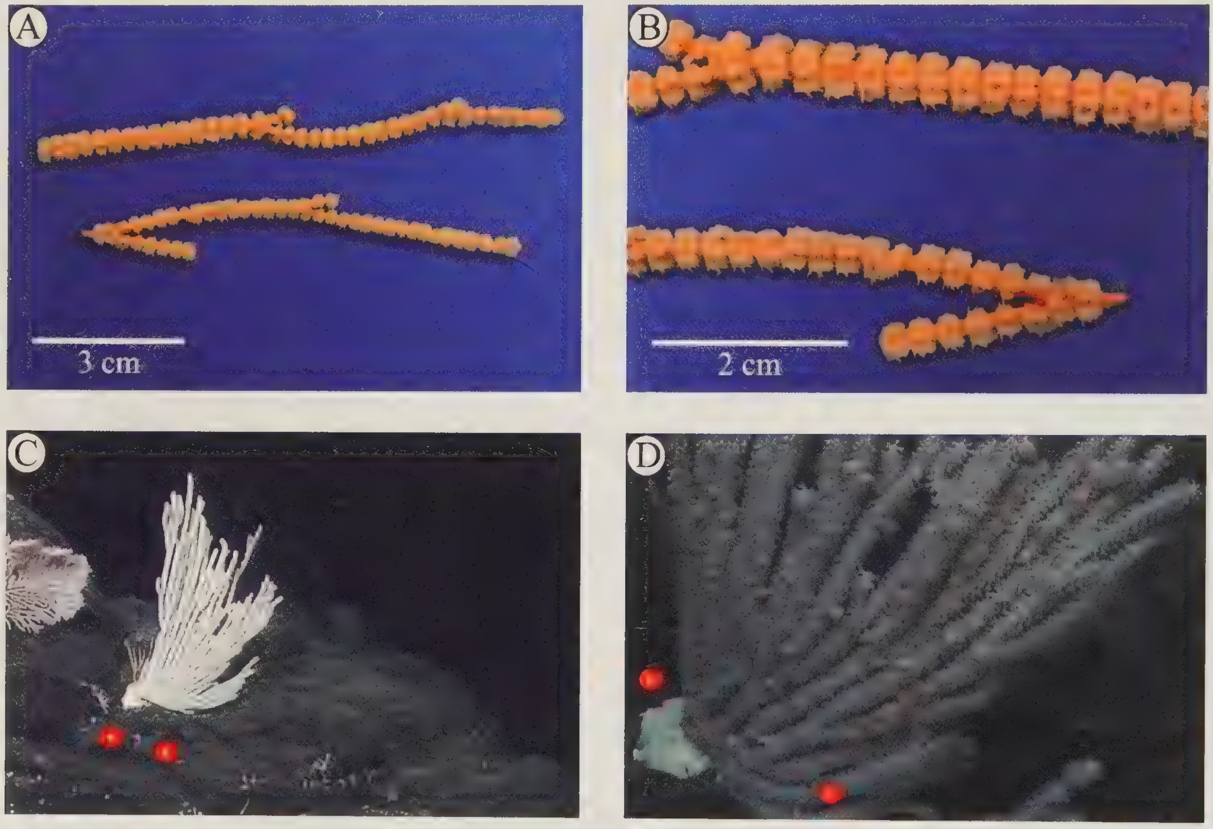


Figure 13-10

A map of the North Pacific Ocean showing the distribution of *Narella alaskensis* (+) in Alaska waters.

bedrock (boulders and cobbles) at depths between 2216 and 3204 m. Elsewhere – 2193 m depth.

Photos A) A preserved (in ethanol) branch of a *N. alaskensis* colony (USNM 1080453; paratype) collected on Murray Seamount at a depth of 2680 m. B) A close-up view of the same specimen in photo A. C) A *N. alaskensis* colony (USNM 1075471) collected on Welker Seamount at a depth of 2634 m. D) A close-up view of the same colony in photo C showing attached actiniarians. The distance between the red laser marks in photos C and D is 10 cm.



9. *Narella arbuscula* Cairns and Baco, 2007

Description (Adapted from Cairns and Baco, 2007) Colonies are slightly bushy and dichotomously branched; the terminal branches (30+) are up to 12 cm in length. Colonies measure up to 30 cm in height and width. The branches typically originate just above the holdfast. Colonies appear to be relatively flexible, with long floppy branches that wave gently in the current. The coenenchyme is very thin on most specimens, clearly revealing the axis beneath. All polyps face downward and are arranged in whorls of six or seven. Polyps are large (3.4–4.7 mm in length) with 2.0–2.5 whorls/cm branch length. The axis is a brilliant gold to golden brown; the coenenchyme is very light orange to white in life and in ethanol.

Polyps are protected by eight opercular scales, three pairs of abaxial body wall scales, and one pair of small, oval adaxial buccal scales. The dorsolateral edges of basal scales are sometimes ridged; other body wall scales are not ridged. Coenenchymal scales are elliptical in shape, up to 0.5 mm in diameter, and bear one or two very tall ridges (i.e., a sail scale).

Remarks This species differs from all other Alaska *Narella* by having a gently curved dorsolateral edge to its basal scales and in having larger polyps.

Distribution Uncommon (Fig. 13-11). In Alaska – known only from Giacomini and Derickson Seamounts in the Gulf of Alaska Seamount Province. This species has not been documented on the continental slope or from the Aleutian Islands. Elsewhere – not reported.

Habitat Collected or observed on video footage singly or in small patches on bedrock (basalt) and fractured bedrock (boulders and cobbles) at depths between 2710 and 3432 m.

Photos A) A large portion of a preserved (in ethanol) *N. arbuscula* colony (USNM 1075466; paratype) collected on Giacomini Seamount at a depth of 2819 m. B) A close-up view of the same specimen in photo A. C) The same colony in photo A prior to collection. D) A close-up view of the same colony in photo C. E) A *N. arbuscula* colony (USNM 1074565) collected on Giacomini Seamount at a depth of 2819 m. The distance between the red laser marks in photos C and E is 10 cm.

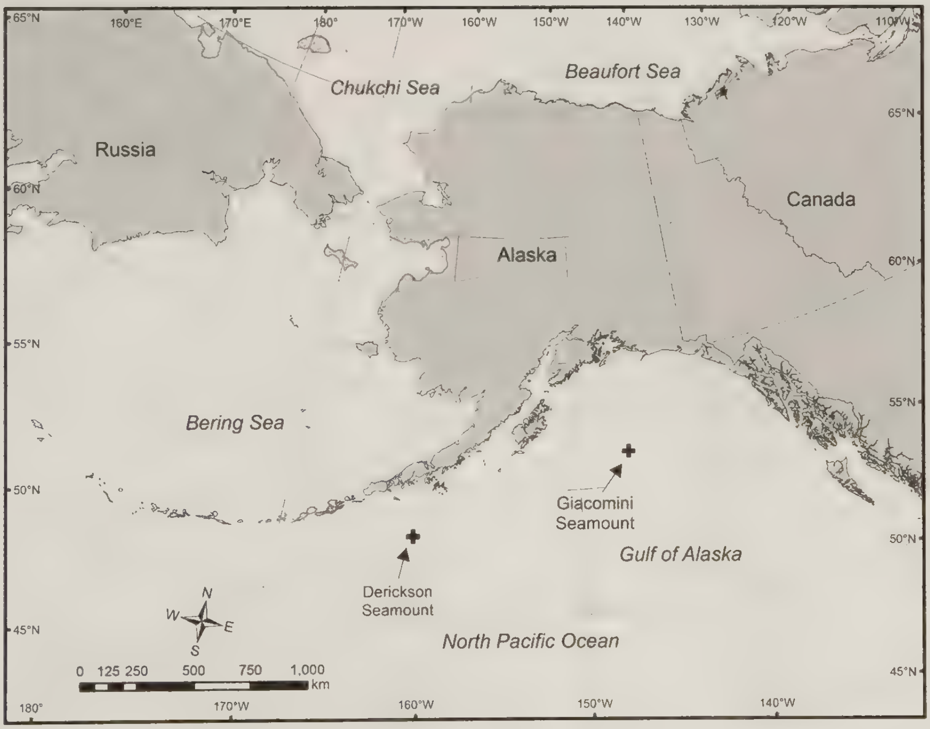
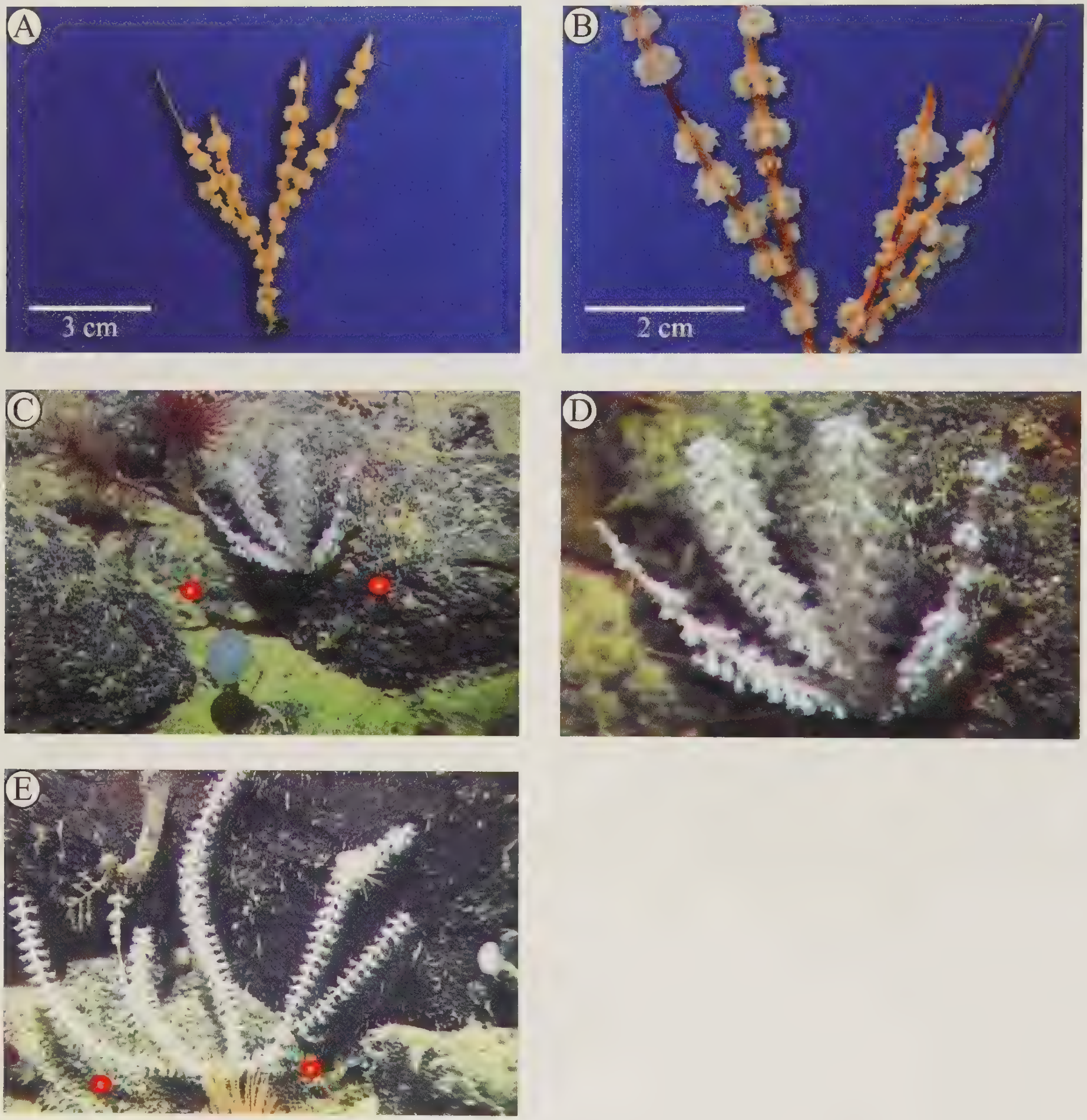

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
Bering Sea
55°N
50°N
+
Giacomini Seamount
50°N
Gulf of Alaska
+
Derickson Seamount
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 13-11

A map of the North Pacific Ocean showing the distribution of *Narella arbuscula* (+) in Alaska waters.

9. *Narella arbuscula* Cairns and Baco, 2007 (continued)


A
3 cm
B
2 cm
C
D
E

10. *Narella bayeri* Cairns and Baco, 2007

Description (Adapted from Cairns and Baco, 2007) Colonies are branched in one plane, with sparse dichotomous branching. Colonies usually have no more than ten branches, but the largest colonies are up to 29 cm in height with 50 branch tips. All polyps face downward and are arranged in whorls of five to seven. Polyps are 2.2–3.4 mm in length with about 3.8 closely spaced whorls per centimeter branch length. The axis is golden brown; the coenenchyme is very light orange to white in life and light orange in ethanol.

Each polyp is protected by eight opercular scales, three pairs of abaxial body wall scales, and one pair of small adaxial buccal scales. The dorsolateral edge of both basal and medial scales forms a 90° corner, which bears a prominent thin ridge; the buccal scales are not angled or ridged. The coenenchymal scales are fusiform, up to 2.1 mm in length, and bear a complex series of tall ridges (i.e., a sail scale) that sometimes forms a network on the outer surface of the scale.

Remarks *Narella bayeri* is compared to the other Alaska species in a tabular key by Cairns and Baco (2007) and to all other species worldwide by Cairns and Taylor (2019). This species has strongly ridged basal and medial scales, crowded whorls, and 5–7 polyps/whorl.

The branches of *N. bayeri* appear to be more rigid than those of *N. arbuscula*, with which it co-occurs. The skeletal axis is composed entirely of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – known from only three specimens: one collected on the continental shelf south of Davidson Bank (western Gulf of Alaska) and two on nearby Derickson Seamount (Fig. 13-12). This is the only *Narella* species documented from the continental slope in the Gulf of Alaska. Elsewhere – not reported.

Habitat Likely occurs singly or in low-density patches (up to 2 colonies/m^2) on moderately steep habitat of bedrock (basalt), fractured bedrock, and conglomerate (a consolidated mix of sand and cobbles), at depths between 3280 and 4092 m.

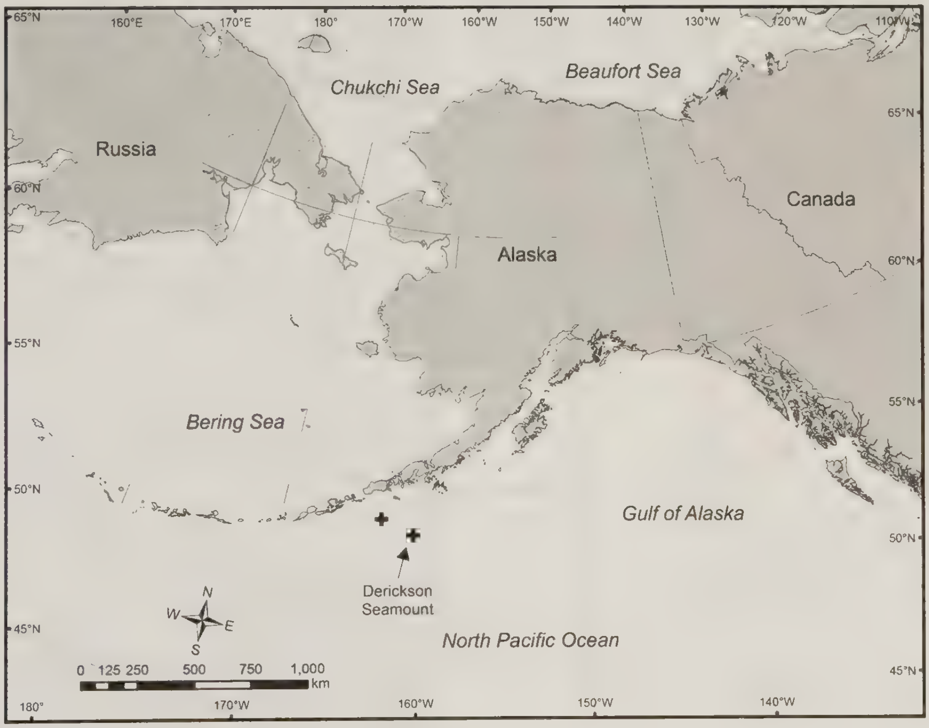
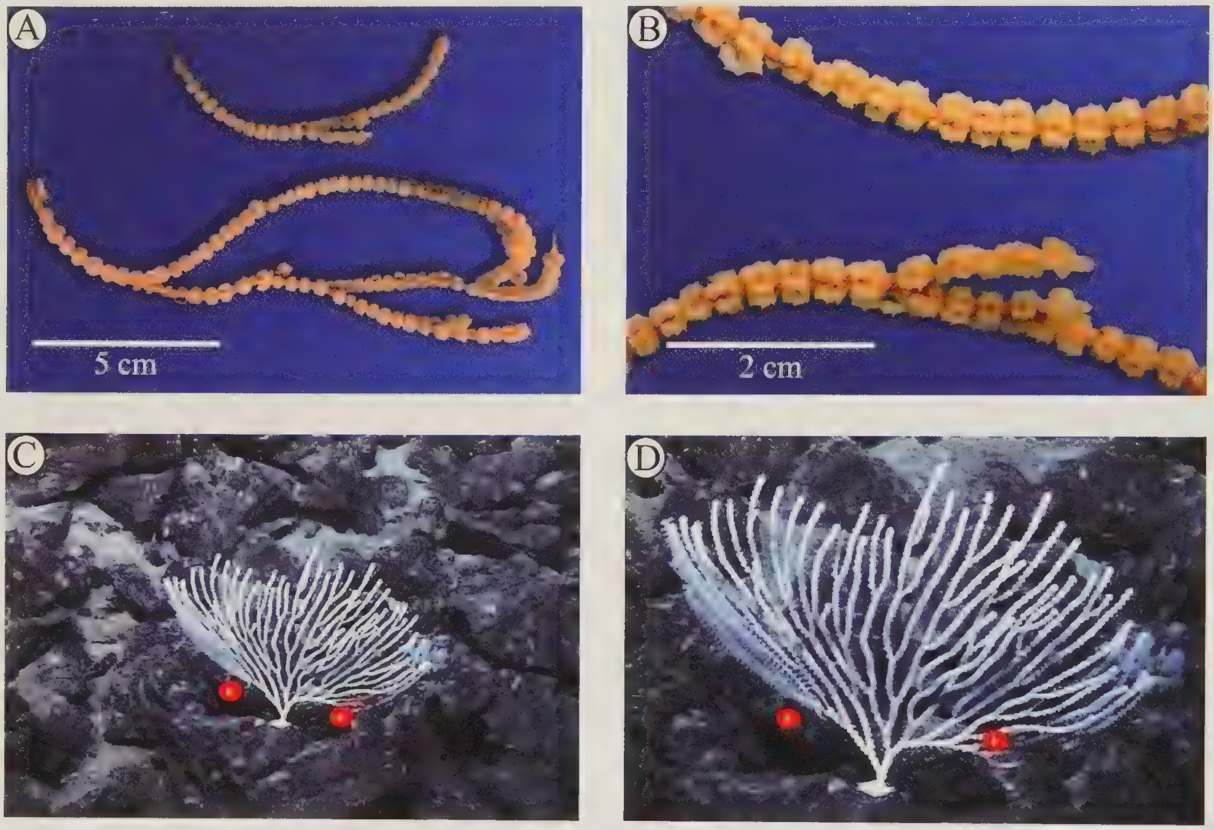

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
Derickson Seamount
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 13-12

A map of the North Pacific Ocean showing the distribution of *Narella bayeri* (+) in Alaska waters.

Photos A) Preserved branches of a *N. bayeri* colony (USNM 1080448; paratype) collected south of Davidson Bank, western Gulf of Alaska, at a depth of 3280 m. B) A close-up view of the same specimen in photo A. C) A *N. bayeri* colony observed on Derickson Seamount at a depth of 3793 m. D) A close-up view of the same colony in photo C. The distance between the red laser marks in photos C and D is 10 cm.



11. *Narella cristata* Cairns and Baco, 2007

Description (Adapted from Cairns and Baco, 2007) The holotype colony has uniplanar, sparse, and dichotomous branching; the longest branch is 8.5 cm in length. The maximum colony height and width is 28 cm. The coenenchyme is very thin on most specimens, clearly revealing the axis beneath. Polyps always face downward and are arranged in whorls of two to four. Polyps are 2.1–3.0 mm in length with 2.5–3.3 whorls/cm branch length. The axis is light to golden brown; the coenenchyme is very light orange to white in life and pinkish in ethanol.

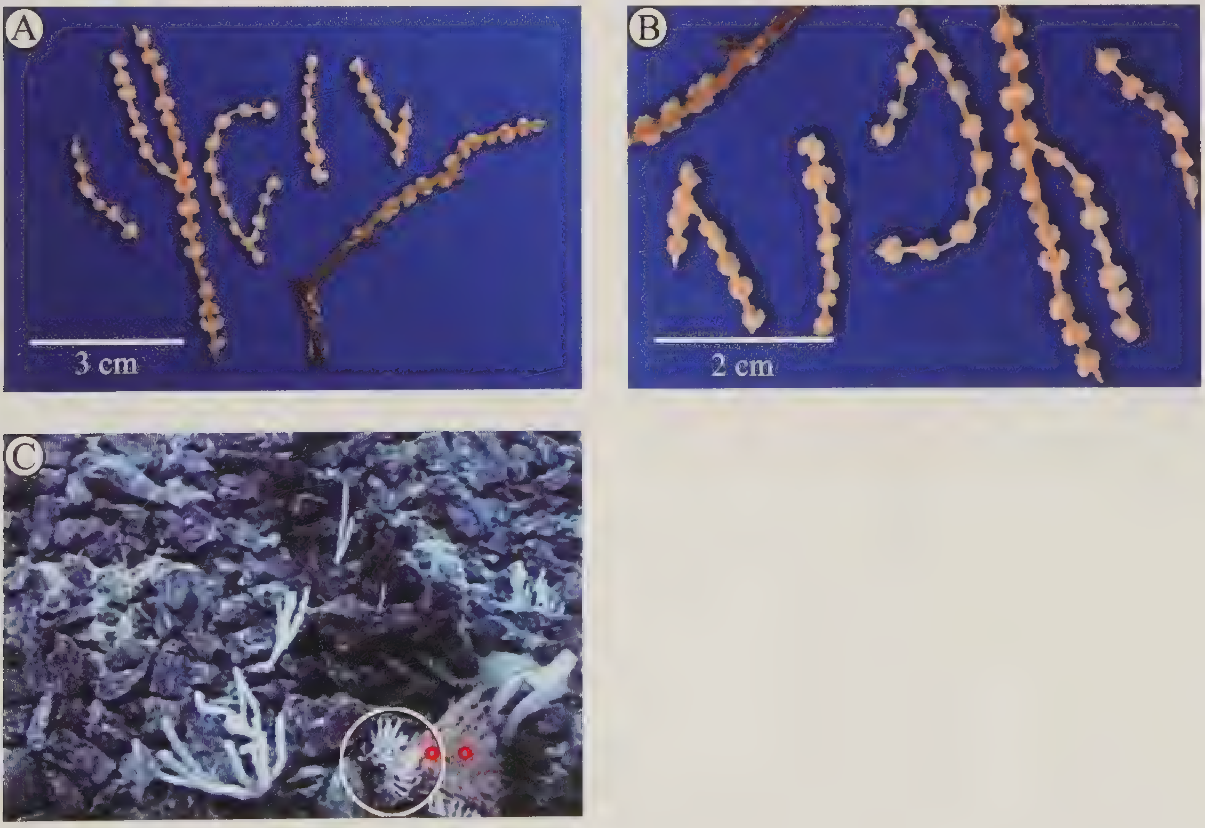
Each polyp is protected by eight opercular scales, three pairs of abaxial body wall scales, and one pair of small, elliptical adaxial buccal scales that bear a small central boss. All three pairs of abaxial body wall scales bear a low ridge on their dorsolateral edges. Coenenchymal scales are fusiform, up to 0.8 mm in length, and each bears a tall medial ridge (i.e., a sail scale).

Remarks This species is similar to *N. bayeri*, but has smaller polyps, fewer polyps per whorl, and fewer whorls per centimeter (Cairns and Baco, 2007).

Distribution Likely rare. In Alaska – known from only a single specimen collected on Derickson Seamount in the Gulf of Alaska Seamount Province (Fig. 13-13). This species has not been documented on the continental slope or from the Aleutian Islands. Elsewhere – not reported.

Habitat Likely occurs singly or in small patches on bedrock (basalt) and fractured bedrock (cobbles) at depths near 3358 m. Observed on video footage to depths as shallow as 3022 m.

Photos A) The preserved (in ethanol) *N. cristata* holotype (USNM 1080449; branch fragments of a colony) collected on Derickson Seamount at a depth of 3358 m. B) A close-up view of the same specimen in photo A. C) The same colony in photo A (indicated by the white circle) prior to collection. The distance between the red laser marks is 10 cm.



11. *Narella cristata* Cairns and Baco, 2007 (continued)

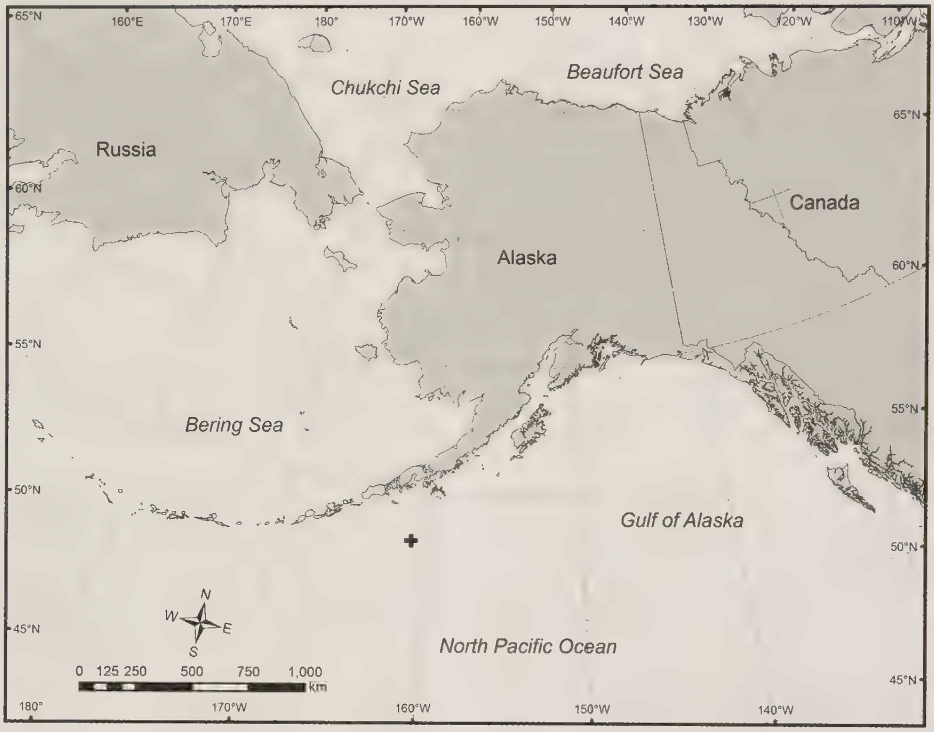

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
+
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 13-13

A map of the North Pacific Ocean showing the distribution of *Narella cristata* (+) in Alaska waters.

12. *Parastenella doederleini* (Wright and Studer, 1889)

Description (Adapted from Cairns, 2011a) Colonies are bushy, dichotomously branched, and relatively small; the largest colony known from Alaska is only 6 cm in height but up to 25 cm in height elsewhere in its geographical range. The axis is dark brown and easily seen through the thin, translucent coenenchyme. The polyps are isolated, in pairs, or in whorls of three, and project perpendicular to the branch; polyps are 2.1–2.5 mm in length. The coenenchyme is light orange to very light pink in life and yellowish in ethanol.

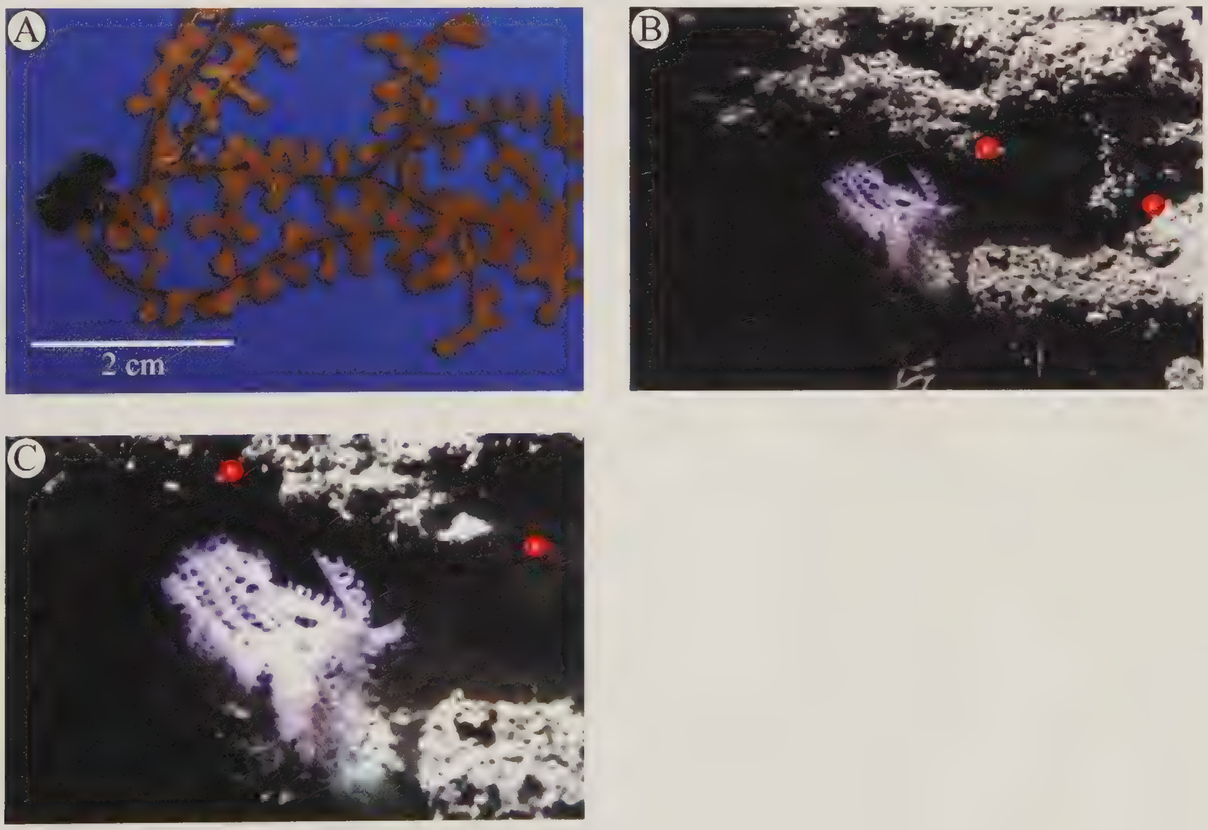
Each polyp is protected by eight opercular scales and five or six longitudinal rows of body wall scales which encircle the polyp (i.e., the adaxial side of the polyp is covered with scales). The eight opercular scales form an asymmetrical rosette of narrowly fluted (almost tubular) scales; some abaxial submarginal body wall scales also bear lesser-fluted scales. The coenenchymal scales are elongate, up to 0.55 mm in length, and often bear a boss or low ridge at the center.

Remarks A key to seven of the eight species in this genus was published by Cairns (2010). *Parastenella* are distinctive from other Primnoidae in having marginal scales offset from the opercular scales and in having large nematocyst pads on the inner surface of its fluted marginal scales (Cairns and Bayer, 2009). *Parastenella doederleini* is most similar to *P. ramosa*, but differs from that species by having longer and narrower fluted marginal scales, ornamented coenenchymal scales, and shorter polyps (Cairns, 2007, 2010, 2011a).

Distribution Likely rare. In Alaska – known from only three specimens collected near Adak Canyon in the central Aleutian Islands (Fig. 13-14). Elsewhere – the holotype was collected off Sagami Bay (Honshu Island, Japan) and one additional specimen is known from the Ceram Sea, Indonesia.

Habitat Attaches to siltstone at depths between 1746 and 2539 m. Elsewhere – found at depths between 732 and 3423 m.

Photos A) A whole preserved (in ethanol) *P. doederleini* colony (USNM 1115561) collected in Adak Canyon, central Aleutian Islands, at a depth of 1746 m. B) A *P. doederleini* colony observed growing on siltstone in Adak Canyon at a depth of 2539 m. C) A close-up view of the same colony in photo B. The distance between the red laser marks in photos B and C is 10 cm.



12. *Parastenella doederleini* (Wright and Studer, 1889) (continued)

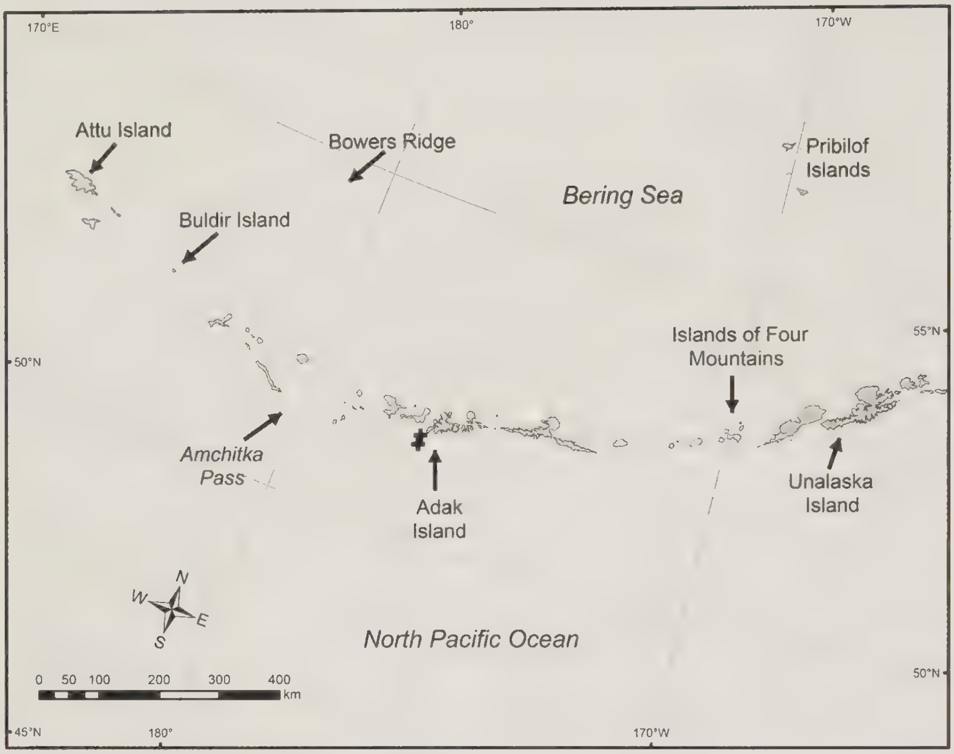

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-14

A map of the Aleutian Islands showing the distribution of *Parastenella doederleini* (**+**) in Alaska waters.

13. *Parastenella gymnogaster* Cairns, 2007

Description (Adapted from Cairns, 2011a) Colonies have uniplanar, irregularly dichotomous branching that rarely is slightly bushy. Colonies have a height and width up to 100 cm. Polyps are isolated in pairs, arranged in whorls of three, face downward, and are 2.2–3.0 mm in length. Colonies are supported by a large, prominent, robust holdfast (≥6 cm in diameter) that is white and reflective in situ. The axis and main branches are bronze in color, lightly striated, and faintly visible through the thin coenenchyme. The coenenchyme is pink, sometimes with a purplish hue, or pale orange in life, and paler shades in ethanol.

Each polyp is protected by eight opercular and eight marginal scales, but proximal to these are only six longitudinal rows of body wall scales; the scales of the abaxial rows are broad and linearly arranged as though stacked. The eight marginal scales form an asymmetrical rosette of short and broad distal flutes; the abaxial submarginal body wall scales also bear flutes. The coenenchymal scales are irregularly shaped, concave above, and bear a complex series of ridges.

Remarks *Parastenella gymnogaster* differs from other Alaska *Parastenella* by having only six rows of body wall scales, broad and short fluted scales, and ornately ornamented coenenchymal scales (Cairns, 2007, 2011a).

Parastenella gymnogaster, along with *Primnoa wingi*, are the only two corals found both in Alaska waters and on the Emperor Seamounts in the central-west Pacific Ocean. The Emperor Seamounts are a series of very old and heavily eroded guyots (flat-topped) and seamounts stretching approximately 6700 km from the Aleutian Trench to the Northwestern Hawaiian Islands (Cairns et al., 2018). They provide an interesting model on the study of the biogeography of North Pacific Ocean corals.

Colonies host several species of ophiuroids (see photo D on next page). Some colonies are completely overgrown with epizoic zoantharians (*Zibrowius* sp.) and are occasionally preyed upon by the sea star *Hippasteria*.

Distribution Uncommon but locally abundant (Fig. 13-15). In Alaska – known only from seamounts in the Gulf of Alaska Seamount Province (Dickens, Welker, Marchand, Chirikof, and Derickson Seamounts). Elsewhere – the Emperor Seamounts in the central-west Pacific Ocean (Jingu, Nintoku, Godaigo, Yomei, and Suiko Seamounts), Juan de Fuca Ridge and Vance Seamount in Oregon, and Monterey Bay Canyon in California.

Habitat In Alaska – occurs singly or in small but sometimes dense patches (>5 colonies/m^2 on Marchand Seamount) on bedrock (basalt), fractured bedrock, boulders, and cobbles including in crevices and under overhangs, at depths between 2193 and 3074 m. Patches of larger colonies resemble the thickets of *Primnoa pacifica* in the eastern Gulf of Alaska. Elsewhere – depths between 1100 m (Monterey Bay Canyon) and 2077 m (Godaigo Seamount).

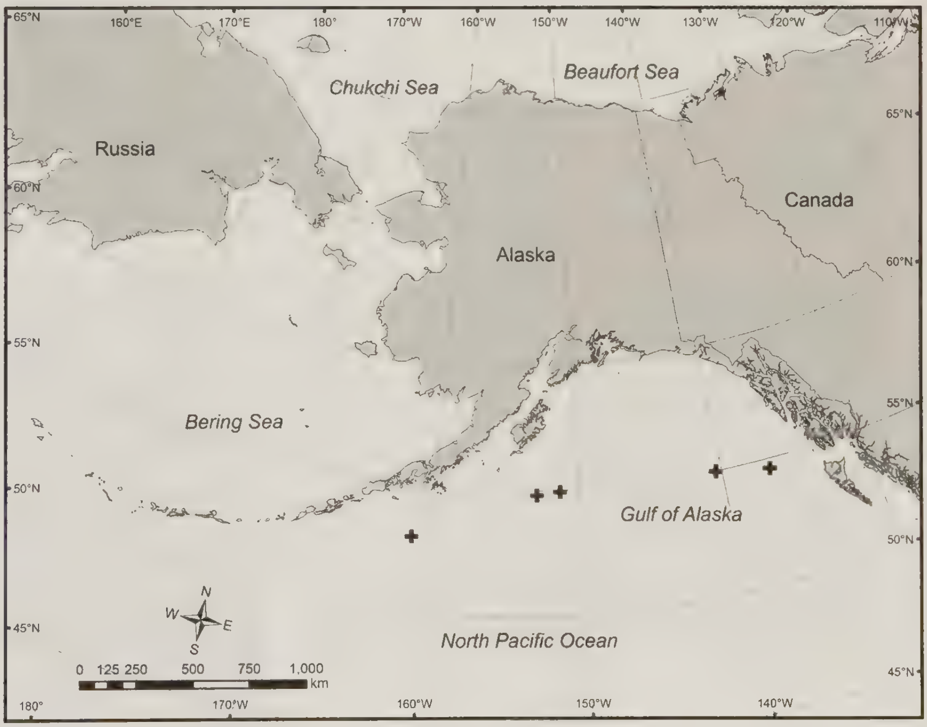
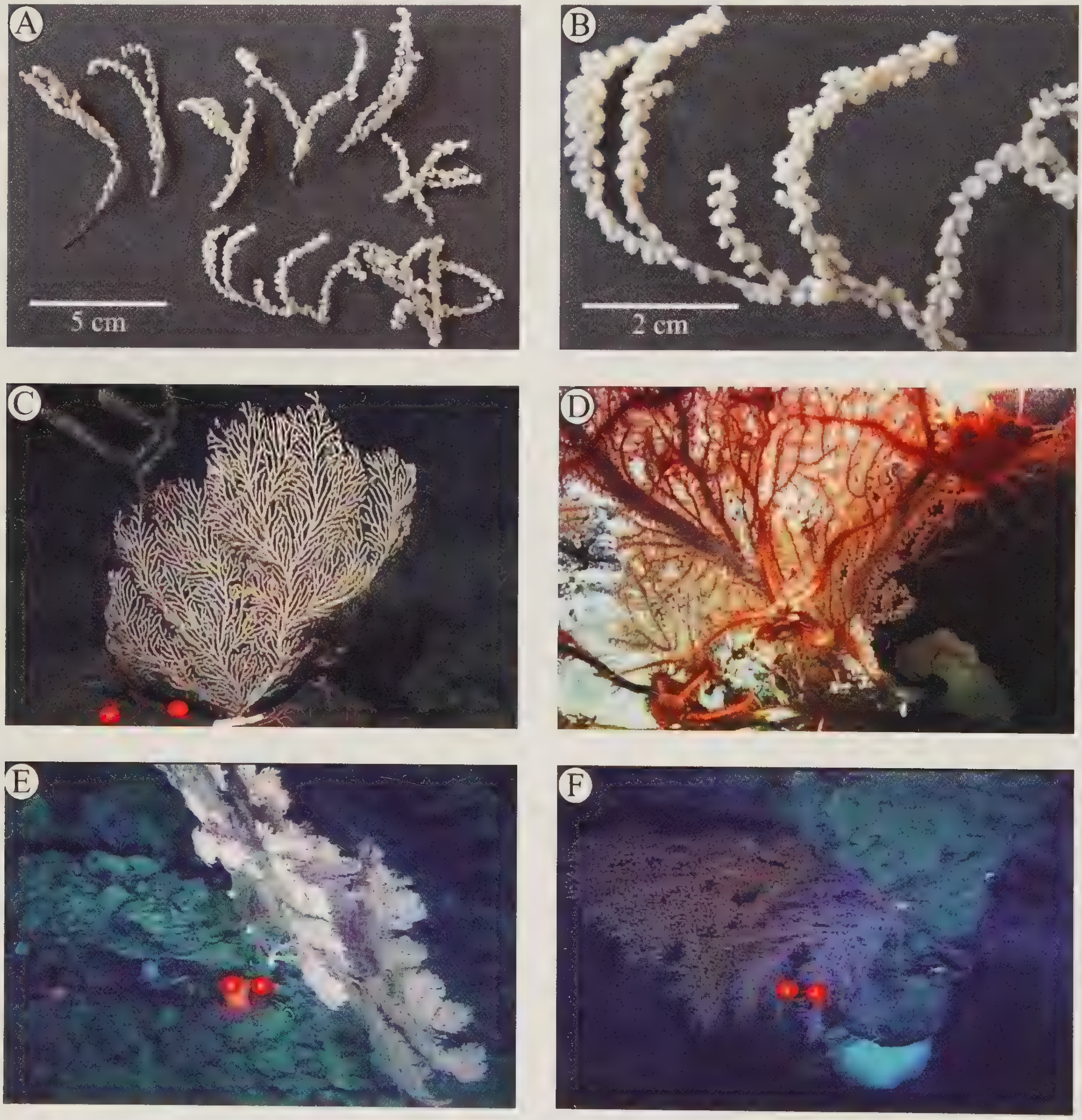


Figure 13-15

A map of the North Pacific Ocean showing the distribution of *Parastenella gymnogaster* (+) in Alaska waters.

Photos A) The preserved (in ethanol) *P. gymnogaster* holotype (USNM 1075463; many branches of a colony) collected on Welker Seamount at a depth of 2635 m. B) A close-up view of the same specimen in photo A. C) A *P. gymnogaster* colony (USNM 1075359) growing on basalt on Dickens Seamount at a depth of 2789 m. D) A *P. gymnogaster* colony (USNM 1075361) growing on basalt on Dickens Seamount at a depth of 2704 m. The base of the colony (with associated ophiuroids) is clearly visible. E) A linear row of six large *P. gymnogaster* colonies growing on bedrock on Marchand Seamount at a depth of 2323 m. F) Two large *P. gymnogaster* colonies observed on Marchand Seamount at a depth of 2316 m. The colony at the upper left is completely overgrown with zoantharians. The distance between the red laser marks in photos C, E, and F is 10 cm.



14. *Parastenella ramosa* (Studer, 1894)

Description (Adapted from Cairns, 2011a) Colonies usually branch in a uniplanar fashion, with irregular, dichotomous branching; the largest colonies measure up to 55 cm in height and 45 cm in width. The axis is dark bronze and usually visible beneath the coenenchyme in live specimens. Polyps occur singly, in pairs and whorls of three, and usually directed basally; polyps are 2.5–3.3 mm in length. The coenenchyme is light orange to white in live specimens and when dried or preserved in ethanol.

Each polyp is protected by eight opercular scales, eight marginal scales, and five rows of body wall scales. The eight marginal scales form an asymmetrical rosette of narrow, almost tubular, fluted scales; abaxial submarginal scales also bear small flutes. The coenenchymal scales are irregular to elliptical in shape, concave above, up to 0.6 mm in diameter, and not ridged.

Remarks This species is similar to *P. doederleini* (see Remarks of that species) and is compared to others in the genus by Cairns (2007, 2011a). Preserved specimens are fragile but live specimens have a strong holdfast and are difficult to dislodge in situ. This may partly explain why seamount specimens are often completely covered with zoantharians (i.e., the skeleton remains intact and attached to the substrate after death, providing clean, elevated substrate for other fauna).

This species hosts a rich suite of associated fauna including amphipods (families Caprellidae, Ischyroceridae, and Pleustidae), the isopod *Munna* sp. (Watling and Stone[7]), ophiuroids including *Asteronyx* sp., and chirostylid crab species. Colonies on Gulf of Alaska seamounts are often overgrown with zoantharian corals (*Zibrowius* sp.). It is preyed upon by the sea star *Hippasteria* sp. (see photo E on next page). The coenenchymal sclerites are composed principally of aragonite (69.2%) and lesser amounts (30.8%) of high-magnesium calcite (8.2 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Common and broadly distributed (Fig. 13-16). In Alaska – eastern Gulf of Alaska continental shelf, Gulf of Alaska Seamount Province (Dickens, Welker, Pratt, Giacomini, Murray, and Patton Seamounts), the central Aleutian Islands (Adak Canyon), and the eastern Bering Sea. Elsewhere – extremely wide-

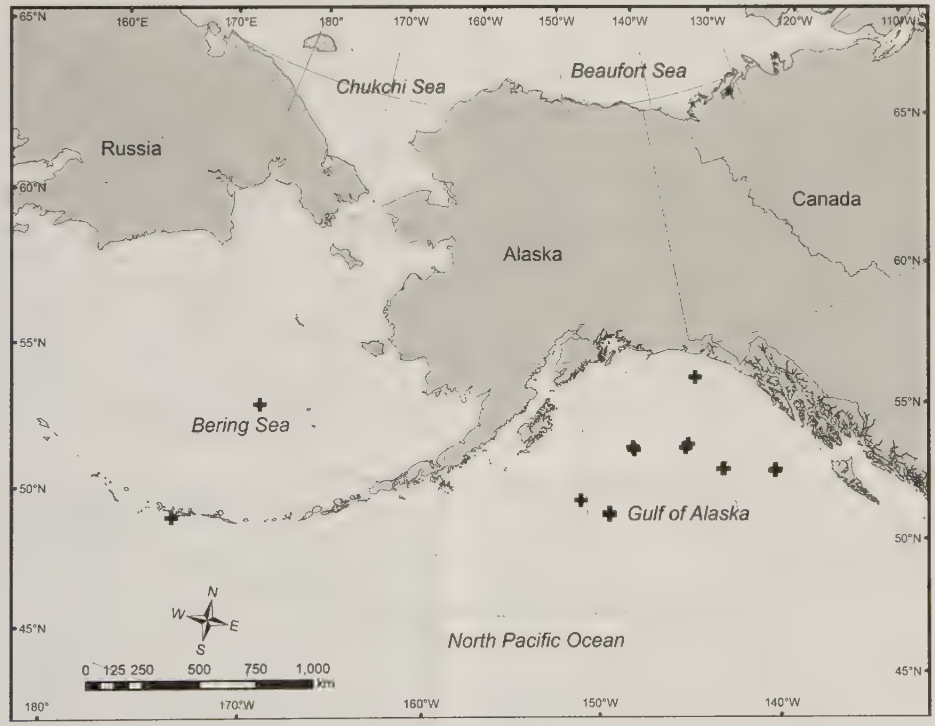


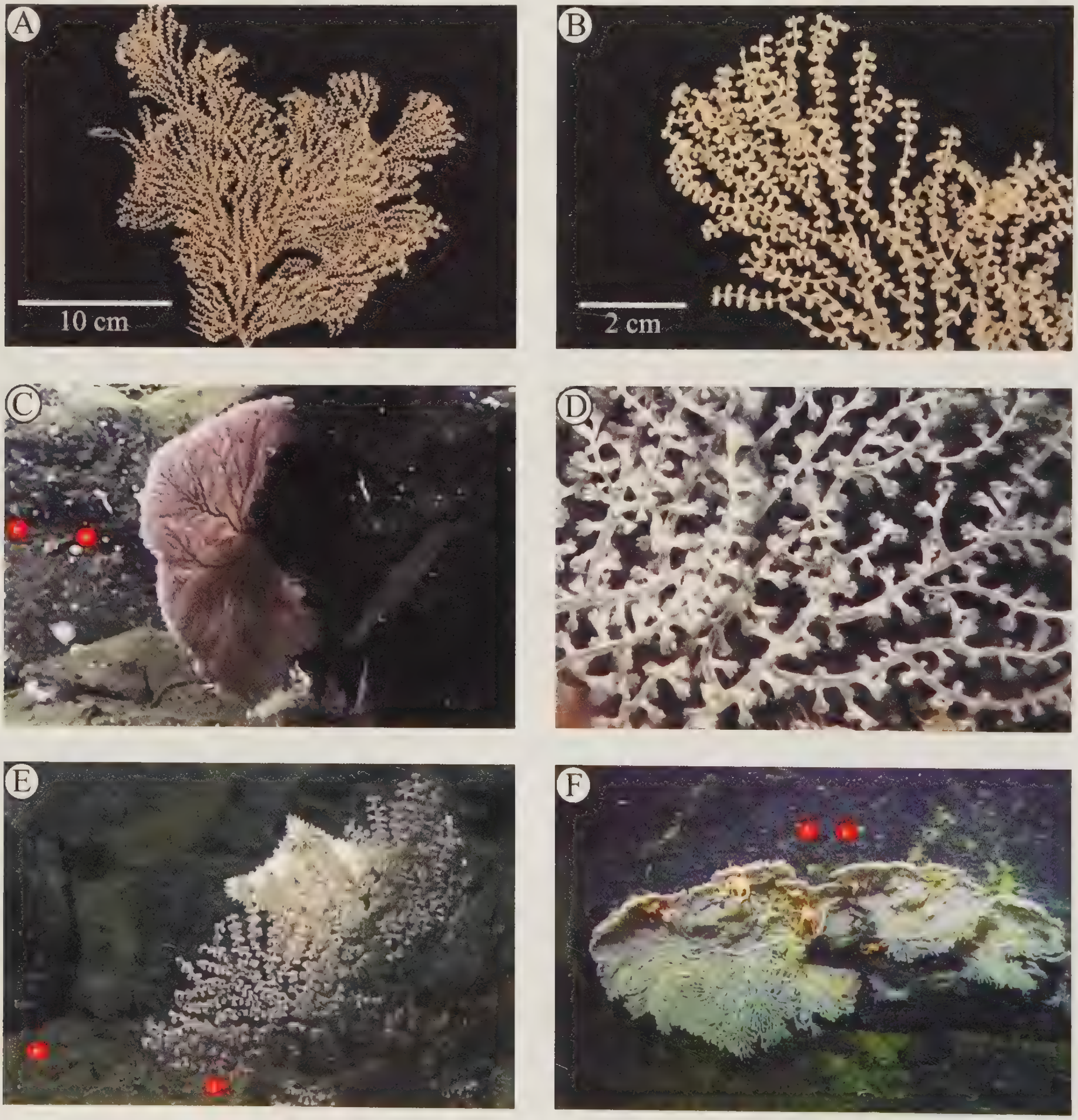
Figure 13-16

A map of the North Pacific Ocean showing the distribution of *Parastenella ramosa* (+) in Alaska waters.

ranging geographically including the western Bering Sea (Commander Islands, Russia), British Columbia, Washington, California, Panama, and Chile.

Habitat In Alaska – occurs singly or in small patches on bedrock including basalt lava flows, fractured bedrock, boulders, cobbles, and occasionally siltstone, at depths between 667 and 1937 m. Observed growing on hexactinellid (*Chonelasma oreia*) skeleton on Welker Seamount (Gulf of Alaska Seamount Province) at a depth of 1123 m. Elsewhere – depths between 619 m (Channel Islands, California) and 1805 m (off Vancouver Island, British Columbia).

Photos A) A dried whole *P. ramosa* colony (USNM 1075364) collected on Dickens Seamount at a depth of 850 m. B) A close-up view of the same specimen in photo A. C) A *P. ramosa* colony (USNM 1481813) growing on bedrock in Adak Canyon, central Aleutian Islands, at a depth of 1429 m. D) A close-up view of a *P. ramosa* colony (USNM 1075377) growing on basalt on Pratt Seamount at a depth of 960 m. E) A *P. ramosa* colony (USNM 1075379) being preyed upon by a sea star (*Hippasteria* sp.) on Pratt Seamount at a depth of 918 m. F) A band of *P. ramosa* colonies, including specimen USNM 1075367 (at left), on Welker Seamount at a depth of 795 m. The colonies host numerous crab (*Sternostylus* sp.), ophiuroids (*Asternonyx* sp.), and zoantharians (*Zibrowius* sp.). The distance between the red laser marks in photos C, E, and F is 10 cm.



15. *Plumarella aleutiana* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies branch in a uniplanar, regular, alternate-pinnate manner; the largest known colony is 56 cm in height and 42 cm in width. The axis is brown to black and somewhat stiff. Polyps occur on all sides of the branches in a crowded fashion with 20–35 polyps/cm branch length. Polyps are small (only 0.9–1.2 mm in length) and cylindrical to slightly flared. The coenenchyme is bright orange to pink in life and orange when dried.

Each polyp is covered with eight opercular scales and eight longitudinal rows of body wall scales; the sclerite formula is 5–9: 4–6: 2–5: 2–4. The tip of the marginal scales is sometimes spinose or triangular in shape; the margin of the other body wall scales is coarsely serrate. The coenenchymal scales are irregular in shape, usually elongate, up to 0.6 mm in length, and finely granular; smaller (0.05–0.09 mm in diameter) spiny spheroids are also present.

Remarks Seven of the eight Alaska *Plumarella* species have polyps that occur on all sides of their branches (versus only on alternating sides) and based on that characteristic were placed in the now defunct subgenus *Dicholaphis*. Of those seven taxa, *Plumarella aleutiana* is most similar to *P. superba* (Nutting, 1912) but differs in having pinnate (not bottlebrush) branching and coarsely serrate body wall scales (Cairns, 2011a). A key to the Alaska species of this now defunct subgenus (*Dicholaphis*) is given by Cairns (2011a), including a list of all *Plumarella* species known at that time.

This species hosts a rich suite of associated fauna including amphipods (families Caprellidae, Ischyroceridae, and Pleustidae), ophiuroids, polynoid polychaetes, and antarcturid isopods (Watling and Stone[7]). Bivalves (Paranoidae, *Aricidea* [*Acmira*] sp.) occasionally attach to exposed branch axes. The skeletal axis is composed of high-magnesium calcite (14.3 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Common, locally abundant. In Alaska – Aleutian Islands near Akutan Island to west of Attu Island including Petrel and Bowers Banks, the eastern Bering Sea to the Pribilof Islands, and Patton Seamount in the Gulf of Alaska Seamount Province (Fig. 13-17).

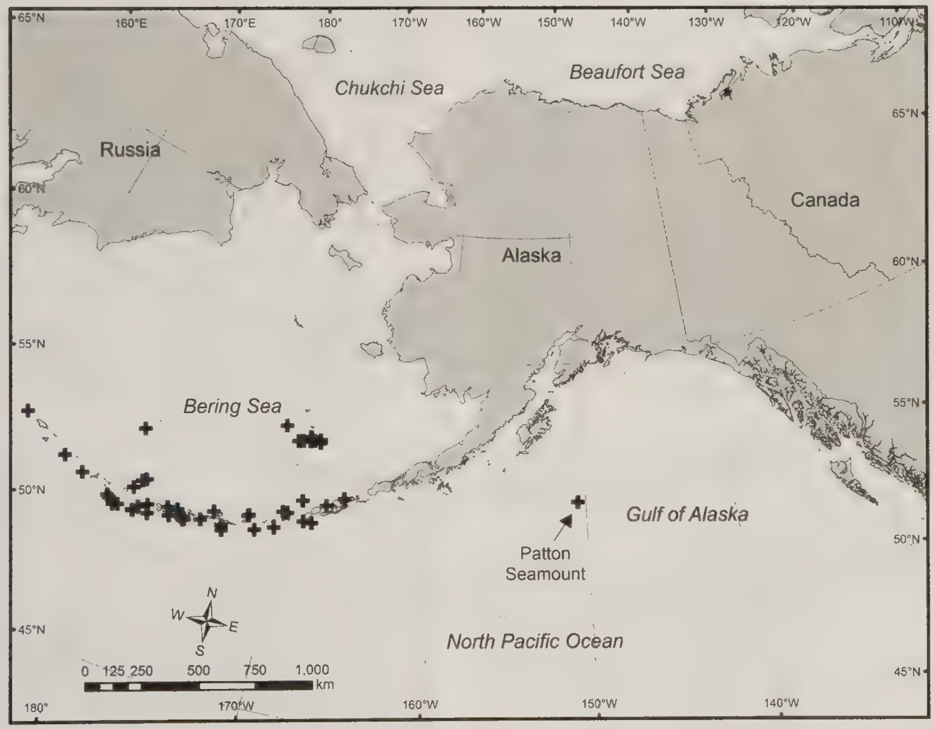


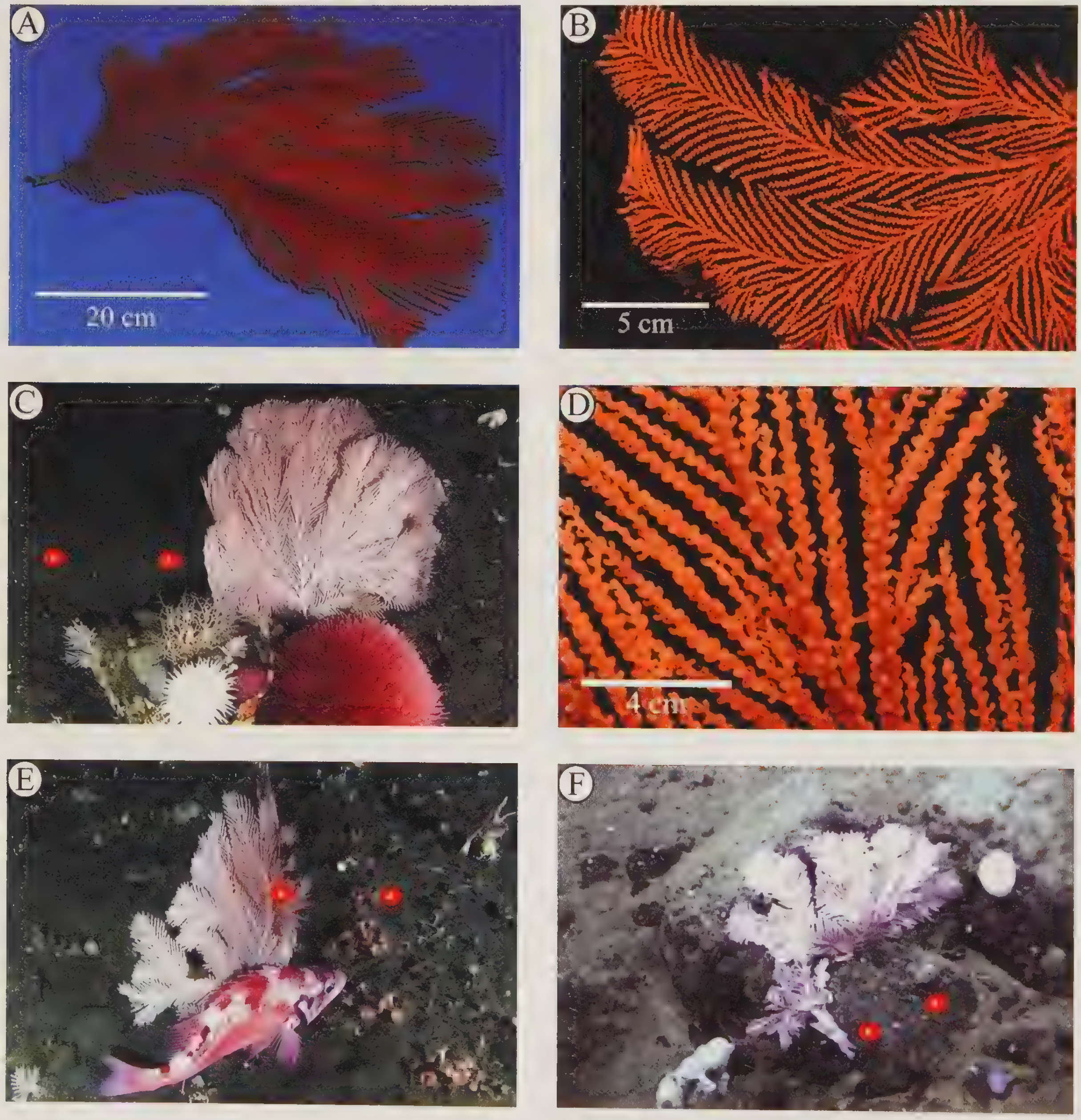
Figure 13-17

A map of the North Pacific Ocean showing the distribution of *Plumarella aleutiana* (+) in Alaska waters.

This is the only species of *Plumarella* reported from the Gulf of Alaska Seamount Province. Elsewhere – not reported.

Habitat Occurs in small patches and large fields on bedrock, boulders, cobbles, pebbles, and occasionally gastropod shell. Extremely eurybathic; found at depths between 79 and 2828 m.

Photos A) A fresh whole *P. aleutiana* colony (USNM 1134755) collected southwest of Atka Island, central Aleutian Islands, at a depth of 119 m. B) A close-up view of a fresh *P. aleutiana* specimen (USNM 1201880) collected in Pribilof Canyon, eastern Bering Sea, at a depth of 300 m. C) A *P. aleutiana* colony (USNM 1116845) collected in Pribilof Canyon at a depth of 310 m. D) A close-up view of the same specimen (fresh) in photo C. E) A *P. aleutiana* colony observed in Pribilof Canyon at a depth of 239 m. A Pacific ocean perch (*Sebastes alutus*) takes refuge beside the colony. F) A cluster of three *P. aleutiana* colonies observed in Adak Canyon, central Aleutian Islands, at a depth of 2196 m. The distance between the red laser marks in photos C, E, and F is 10 cm.



16. *Plumarella echinata* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies branch in a uniplanar, regular, alternate-pinnate manner; the largest known colony is 28 cm in height and width. Larger colonies may have relatively large, robust holdfasts (up to 3 cm in diameter) that are white and reflective in situ (see photo D on next page). Polyps occur on all sides of the branches in a crowded fashion, with 20–30 polyps/cm of branch length; polyps are slightly flared distally and 1.1–1.4 mm in length. The axis is bronze and fairly flexible; the coenenchyme is light orange to pink in life and a pale yellowish orange when dried.

Each polyp is covered with eight opercular scales and eight longitudinal rows of body wall scales; the sclerite formula is 3–5: 3–4: 2–3: 2–4. Most marginal scales are prominently spinose; the spines themselves are spiny and not ridged or smooth. The submarginal scales also bear shorter spines, and the remainder of the body wall scales have a triangular margin. Coenenchymal scales are elongate, coarsely granular, and up to 0.55 mm in length.

Remarks This species has elongate, spiny marginal scales and relatively few body wall scales; these characteristics distinguish it from all other Alaska *Plumarella* that have polyps on all sides of the branches (i.e., those species formerly placed in the subgenus *Dicholaphis*).

Associated fauna include nemertean polychaetes (Watling and Stone[7]). Small actiniarians occasionally attach to exposed branch axes. The coenenchyme is composed of high-magnesium calcite (14.2 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Common. In Alaska – Aleutian Islands, south of Amukta Pass to Buldir Reef, including Petrel and Bowers Banks (Fig. 13-18). Elsewhere – not reported.

Habitat Occurs in small patches on bedrock, boulders, cobbles, and pebbles at depths between 150 and 1692 m.

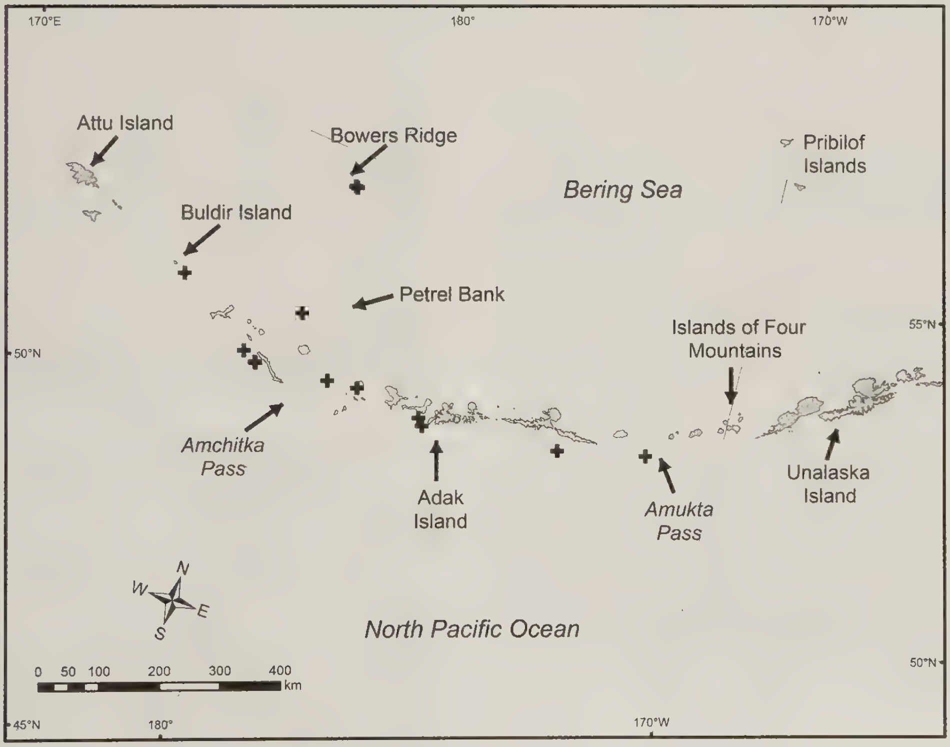
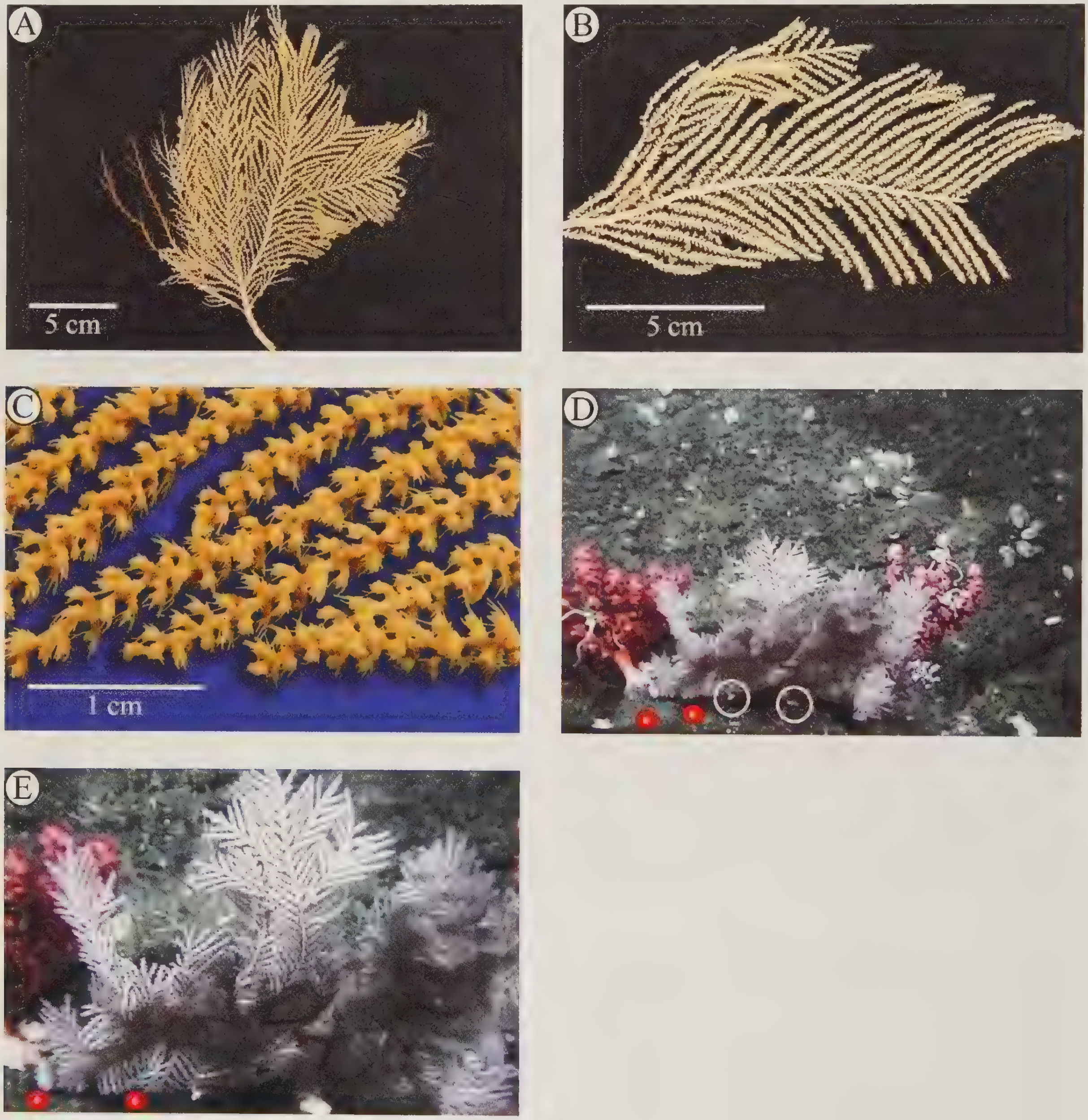

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-18

A map of the Aleutian Islands showing the distribution of *Plumarella echinata* (+) in Alaska waters.

Photos A) A dried whole (except the holdfast) *P. echinata* colony (USNM 1135993) collected in Adak Canyon, central Aleutian Islands, at a depth of 1692 m. B) A dried whole (except the holdfast) *P. echinata* colony (USNM 1131995) collected in northern Amchitka Pass, central Aleutian Islands, at a depth of 711 m. C) A close-up view of the same specimen in photo B. D) Two large *P. echinata* colonies (holdfasts indicated by the white circles) collected southwest of Amlia Island, central Aleutian Islands, at a depth of 844 m. Colony USNM 1134500 is at left. E) A close-up view of the same colonies in photo D. The distance between the red laser marks in photos D and E is 10 cm.



17. *Plumarella hapala* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies branch in a uniplanar, coarsely alternate-pinnate manner; the largest known colony is 26 cm in height and 22 cm in width. Polyps occur on all sides of the branches in a crowded manner, with 18–25 polyps/cm of branch length. The polyps are distally flared, somewhat fragile (often damaged during collection), and large (2.0–2.4 mm in length). The axis is yellowish-brown and relatively stiff. The coenenchyme is light orange to pink in life and light orange to cream when dried.

Each polyp is protected by eight opercular scales and eight rows of body wall scales; the sclerite formula is 6–8: 5–7: 3–6: 5–8. The tips of most marginal scales are pointed (not spinose); the submarginal scales are progressively less pointed. The body wall scales are thin. The coenenchymal scales are elliptical to rectangular, with a smooth outer surface.

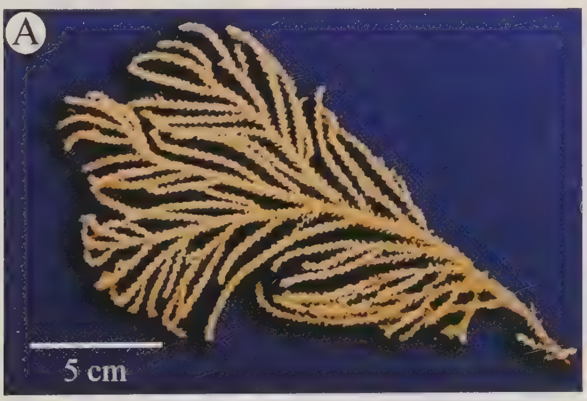
Remarks This species is most similar to *Plumarella aleutiana*, but differs in having larger polyps that are more fragile due to the thin body wall scales.

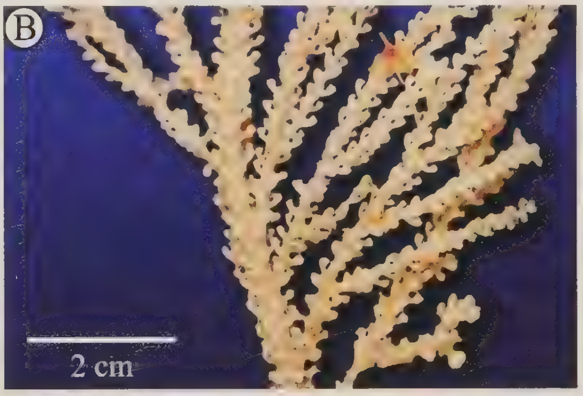
Associated fauna include amphipods (family Ischyroceridae), the isopod *Arctura* sp. (Watling and Stone[7]), and ophiuroids. The axial holdfast is composed of aragonite (senior author and S. D. Cairns, unpubl. data).

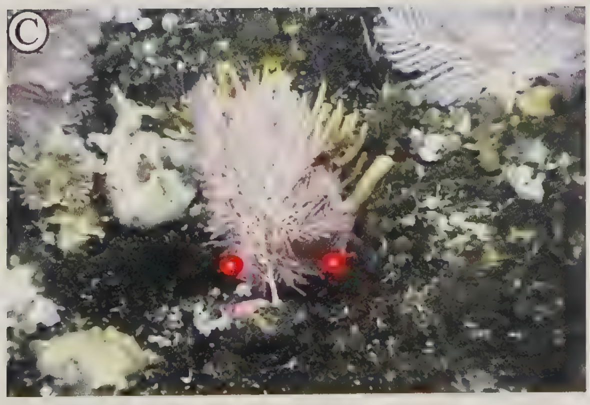
Distribution Common. In Alaska – Aleutian Islands from the Islands of Four Mountains to southwest of Buldir Island including Petrel Bank (Fig. 13-19). Elsewhere – not reported.

Habitat In Alaska – occurs in small patches on bedrock, boulders, cobbles, and pebbles at depths between 120 and 407 m.

Photos A) A dried whole (except the holdfast) *P. hapala* colony (USNM 1134212) collected in Amchitka Pass, central Aleutian Islands, at a depth of 120 m. B) A close-up view of the same specimen in photo A. C) A *P. hapala* colony (USNM 1134094) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 192 m. The distance between the red laser marks is 10 cm.







17. *Plumarella hapala* Cairns, 2011 (continued)

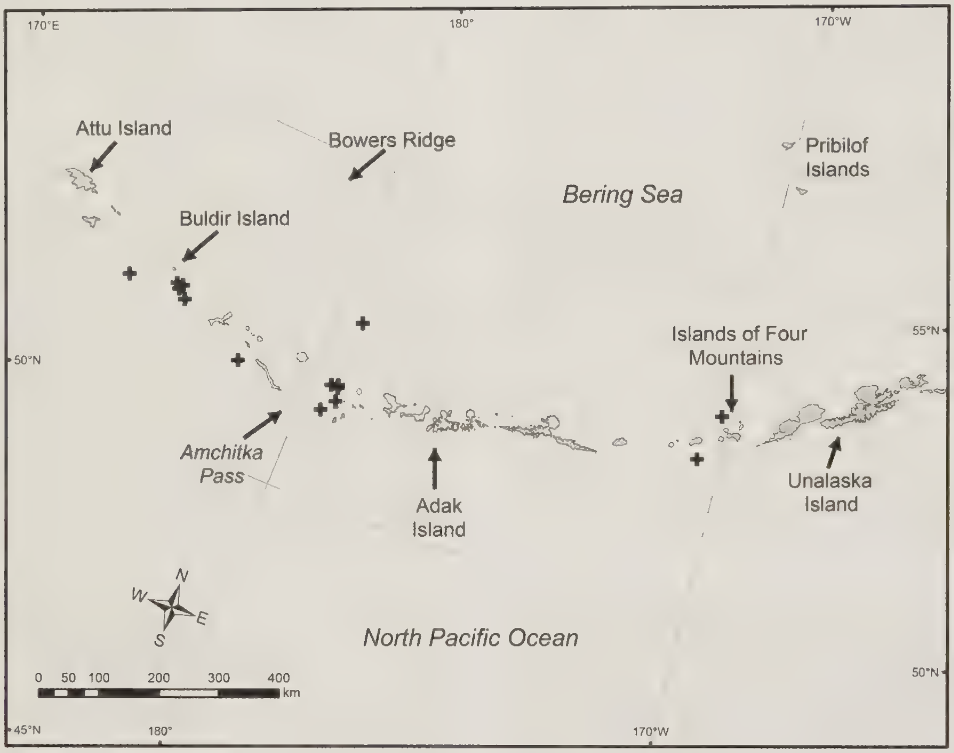

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-19

A map of the Aleutian Islands showing the distribution of *Plumarella hapala* (+) in Alaska waters.

18. *Plumarella nuttingi* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies consist of relatively few main branches arranged in a plane from which smaller branchlets diverge in a bottlebrush fashion; the largest known colony is only 19 cm in height. Polyps occur on all sides of the branchlets with only 9–13 polyps/cm of branchlet length. The polyps are 3.0–3.6 mm in length and are slightly flared and fleshy. The basal region (6–8 mm) of each branchlet is immersed in a thin coenenchymal membrane that contains scales. The axis is light brown to pale yellow; the coenenchyme is light orange to pink in life and light orange when dried.

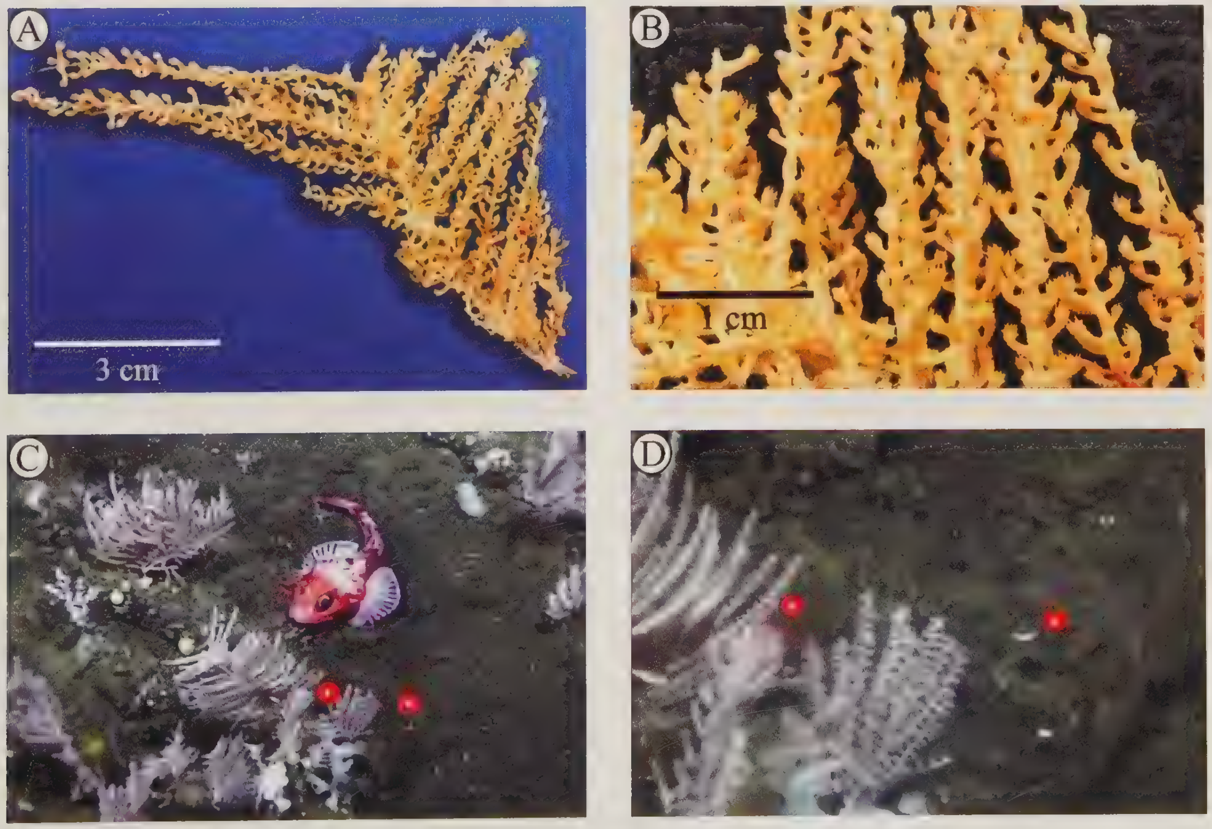
Each polyp is protected by eight opercular scales and eight rows of body wall scales; the sclerite formula is 7–8: 7–8: 6–7: 6–7. The tips of the marginal scales are pointed to spinose; the remaining body wall scales have a serrate distal edge. Coenenchymal scales are elliptical and flat with a granular outer surface.

Remarks This species is distinctive in having large polyps and consequently a low number of polyps per unit area and a coenenchymal membrane around the bases of branchlets. It shares the bottlebrush branching pattern only with *P. superba*.

Distribution Rare (Fig. 13-20). In Alaska – known from only nine specimens collected from three locations in the central Aleutian Islands, northeast of Great Sitkin Island to southern Amchitka Pass. Elsewhere – not reported.

Habitat Occurs singly or in small patches on bedrock, boulders, and cobbles at depths between 350 and 888 m.

Photos A) A large portion of a dried *P. nuttingi* colony (USNM 1006331; paratype) collected northeast of Great Sitkin Island, central Aleutian Islands, at a depth of 350 m. B) A close-up view of the same specimen in photo A. C) A small *P. nuttingi* colony (USNM 1134464; paratype; between the red laser marks) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 888 m. A shortspine thornyhead (*Sebastolobus alascanus*) rests nearby. D) A close-up view of the same colony in photo C. The distance between the red laser marks in photos C and D is 10 cm.



18. *Plumarella nuttingi* Cairns, 2011 (continued)

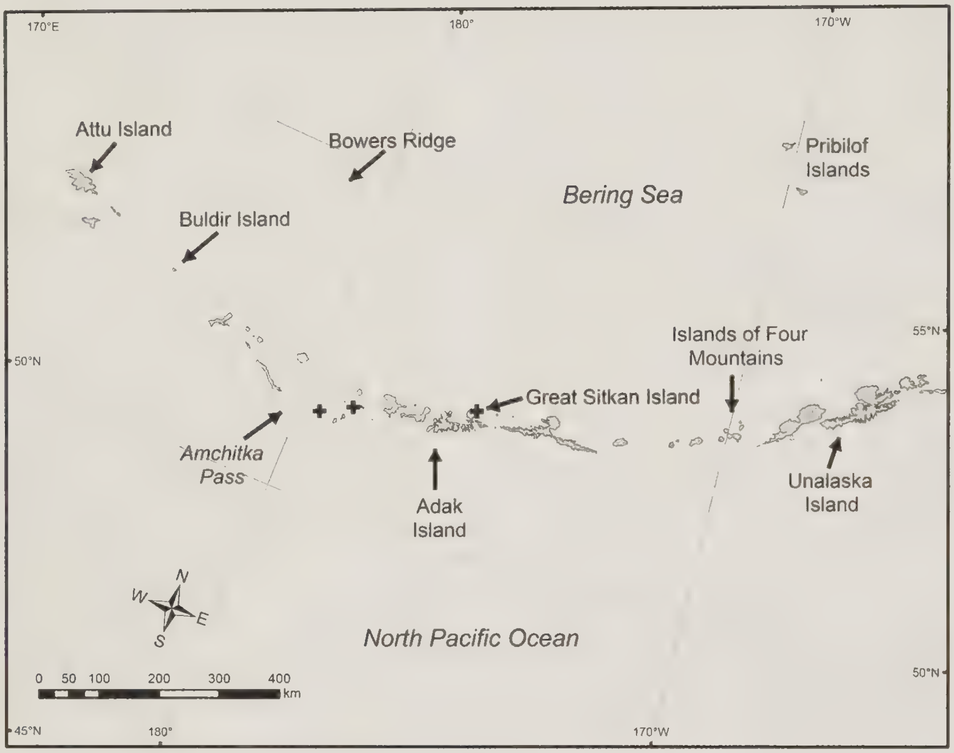

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Great Sitkan Island
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-20

A map of the Aleutian Islands showing the distribution of *Plumarella nuttingi* (+) in Alaska waters.

19. *Plumarella profunda* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies branch in a uniplanar, loose, alternate-pinnate manner; colonies are delicate but quite flexible. The largest known specimen is only 21 cm in height and 14 cm in width but with 24 branch tips and 4th order branching. The axis is a light brown to pale yellow and often visible under the thin coenenchyme. Polyps are 1.5–1.9 mm in length and occur on all sides of the branches with 10–14 polyps/cm of branch length. The coenenchyme is light orange to pink in live specimens and in ethanol.

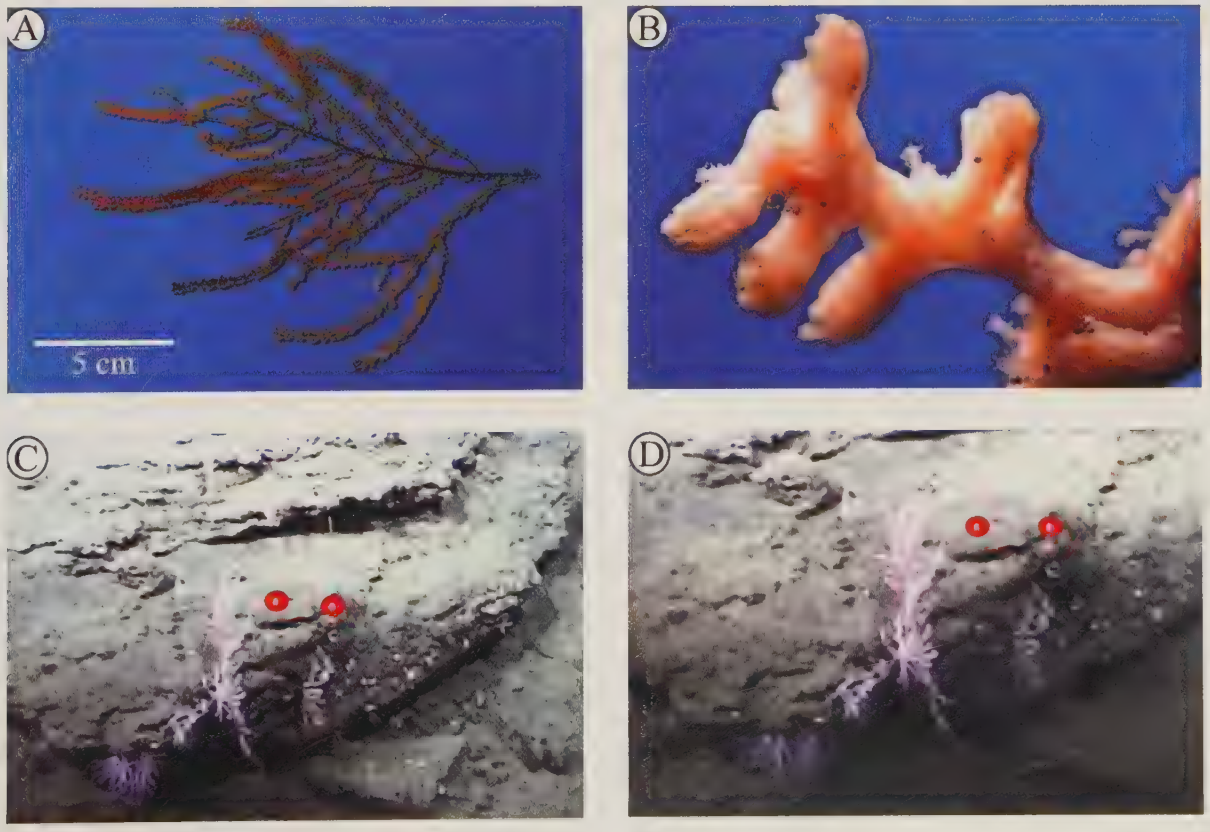
Each polyp is protected by eight opercular scales and eight rows of body wall scales; the sclerite formula is 5: 5: 4: *x* (variable). All body wall scales are roughly rectangular in shape, with a straight, finely serrate distal margin; the outer surface of the body wall scales are smooth to finely granular. Opercular scales are elongate (0.47–0.86 mm in length), and somewhat triangular and pointed. The coenenchymal scales are elliptical to circular, 0.1–0.3 mm in diameter, and bear low granules on their outer surface.

Remarks This species is unique among the Alaska *Plumarella* in having rectangular body wall scales and elongate opercular scales. It was thought to be the deepest dwelling species in the subgenus *Dicholaphis* (a subgenus no longer accepted) when it was first described, hence the species name. Only *P. aleutiana* has been documented at greater depths.

Distribution Rare. In Alaska – known from only two specimens collected at the same location in Adak Canyon, central Aleutian Islands (Fig. 13-21). Elsewhere – not reported.

Habitat Occurs singly or in small but dense patches (up to 10 colonies/m^2) on siltstone at depths around 2514 m.

Photos A) The preserved (in ethanol) *P. profunda* holotype (USNM 1134074; whole colony except holdfast) collected in Adak Canyon, central Aleutian Islands, at a depth of 2514 m. B) A close-up view of the same specimen in photo A showing the details and arrangement of the polyps. C) The same colony in photo A (at center), in situ. D) A close-up view of the same colony in photo C. The distance between the red laser marks in photos C and D is 10 cm.



19. *Plumarella profunda* Cairns, 2011 (continued)

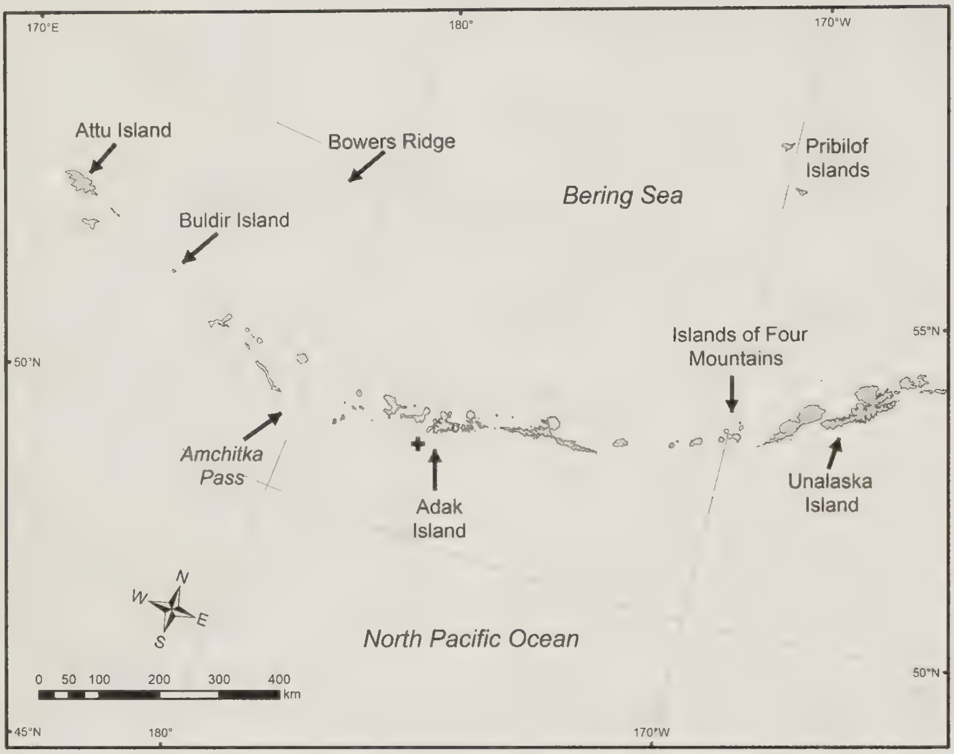

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-21

A map of the Aleutian Islands showing the distribution of *Plumarella profunda* (**+**) in Alaska waters.

20. *Plumarella robusta* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies consist of one main branch or several (up to four), each branching as a uniplanar, alternate-pinnate frond; the largest colonies are 36 cm in height and 32 cm in width. Branchlets are up to 10 cm in length. The axis is fairly flexible and light brown in color. Polyps occur on all sides of the branchlets in a crowded manner with about 20 polyps/cm of branchlet length. Polyps measure 1.4–1.8 mm in length and are cylindrical with a flared tip. Colonies are light pink to orange in life, but light orange to yellow when dried.

Each polyp is protected by eight opercular scales and eight rows of thick body wall scales; the sclerite formula is 4–5: 3–4: 3–4: several. Marginal scales are prominently spinose and the distal spines bear seven or eight spiny, longitudinal ridges. Remaining body wall scales are also spinose or have a pointed distal margin. The coenenchymal scales are elongate, thick, up to 0.6 mm in length, and bear granular radiating ridges on their outer surface.

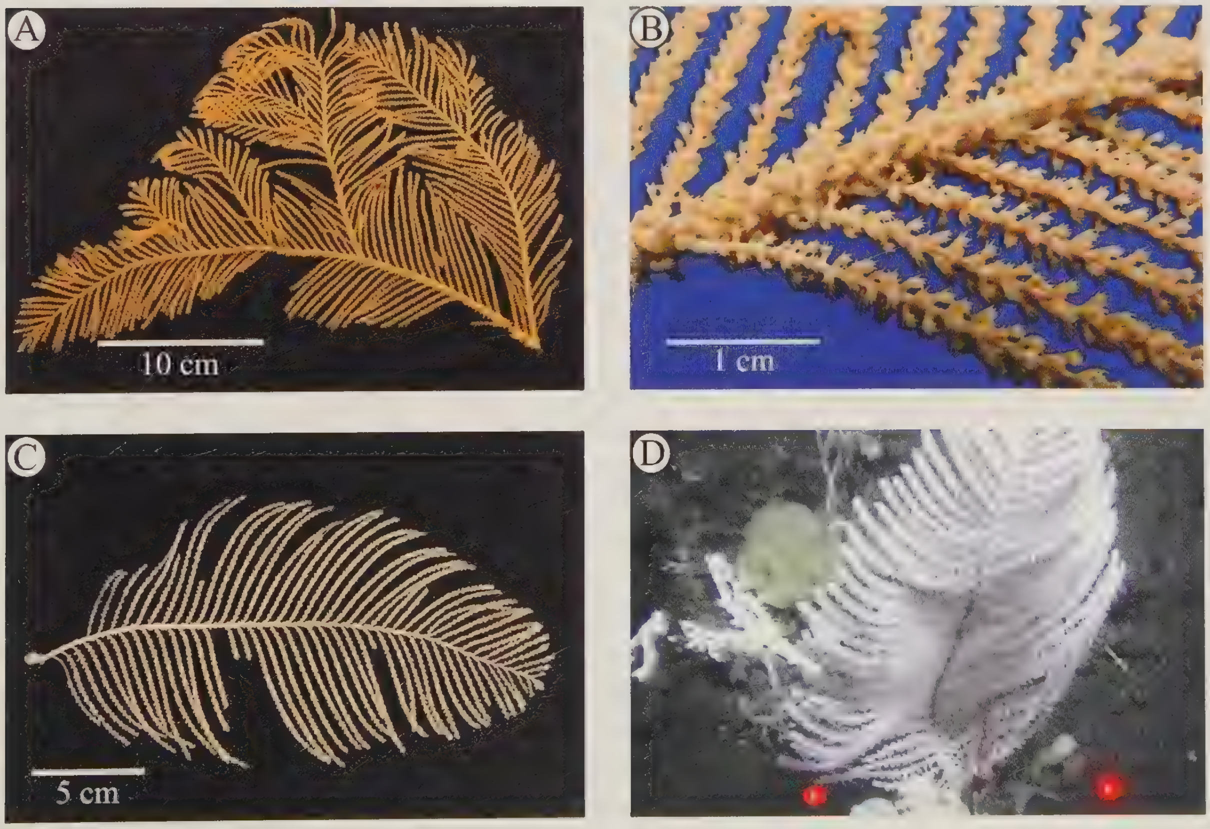
Remarks The marginal spines in this species are similar to those in *P. echinata* but differ in having ridges and thicker body wall scales.

Associated fauna include caprellid amphipods (Watling and Stone[7]) and ophiuroids. Small actiniarians and hydroids occasionally attach to bare branch axes. The coenenchyme is composed of high-magnesium calcite (8.2 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Locally common. In Alaska – known from only seven specimens collected in the central Aleutian Islands (Amchitka Pass and south of Tanaga Island) but video observations indicate that it is common where present (Fig. 13-22). Elsewhere – not reported.

Habitat Occurs in small and large patches on boulders and cobbles at depths between 115 and 1061 m.

Photos A) A dried whole (except the holdfast) *P. robusta* colony (USNM 1481801) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 115 m. B) A close-up view of the same specimen in photo A. C) The dried *P. robusta* holotype (USNM 1135992; whole colony) collected in northern Amchitka Pass, central Aleutian Islands, at a depth of 711 m. D) The same colony in photo C prior to collection. The distance between the red laser marks is 10 cm.



20. *Plumarella robusta* Cairns, 2011 (continued)

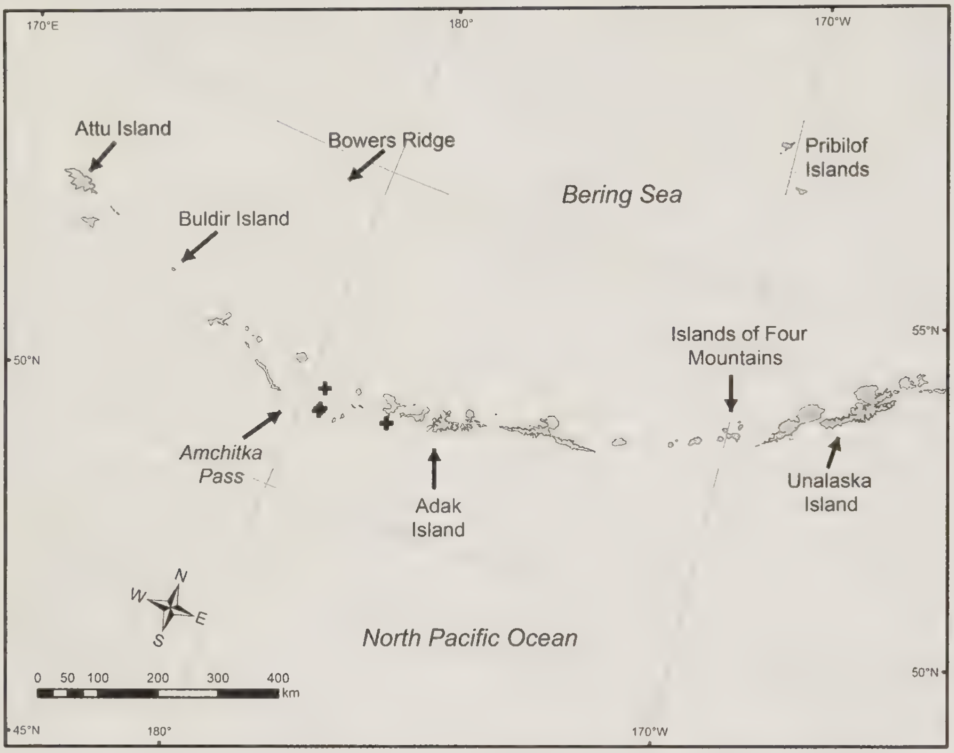

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400
km
50°N
45°N
180°
170°W

Figure 13-22

A map of the Aleutian Islands showing the distribution of *Plumarella robusta* (+) in Alaska waters.

21. *Plumarella spicata* Nutting, 1912

Description (Adapted from Cairns, 2011a) Colonies branch in a uniplanar, quasi-dichotomous fashion or loose alternate-pinnate arrangement; branches are delicate and straggly; the largest known specimen is 27 cm in height and 16 cm in width (USNM 1134073). The branch axes are a golden brown and visible through the thin coenenchyme in live specimens. Polyps occur in an alternating biserial arrangement, usually with about 12–14 polyps/cm of branch length. Polyps are slightly flared and 1.4–1.6 mm in length. The coenenchyme is light orange in life and yellowish orange when dried.

Each polyp is protected by eight opercular scales and eight rows of thick body wall scales; the sclerite formula is 5–6: 5–6: 4–6: 4–6. Opercular scales are elongate and pointed; marginal scales are prominently spinose with the narrow spine constituting up to 70% of the length of the sclerite. Body wall scales have serrate distal margins. The coenenchymal scales are elliptical in outline and coarsely granular.

Remarks *Plumarella spicata* is easily distinguished from all other Alaska *Plumarella* by the arrangement of its polyps in an alternating biserial manner versus on all sides of the branchlets. This arrangement was customarily used to distinguish the subgenus *Plumarella* whereas those species with crowded, randomly arranged polyps were placed in the subgenus *Dicholaphis,* although this nomenclatural distinction is no longer observed. Based on molecular evidence, the two subgenera were recently synonymized (Cairns and Wirshing, 2018).

Distribution Uncommon. In Alaska – central and western Aleutian Islands (Adak Canyon to southeast of Agattu Island) including Bowers Bank (Fig. 13-23). Elsewhere – not reported.

Habitat Occurs singly or in small patches on bedrock, siltstone, boulders, and cobbles in areas of moderate current, and at depths between 712 and 1913 m. This species co-occurs with *P. echinata* and *Acanthogorgia spissa* in dense linear rows on bedrock and siltstone ridges in Adak Canyon (see photo E on next page).

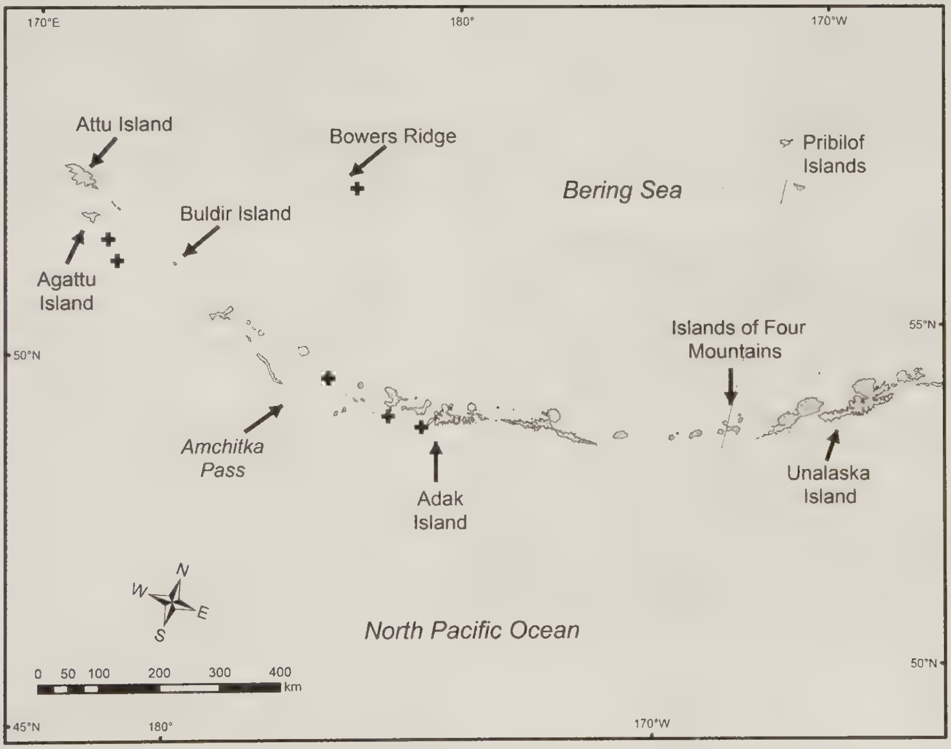
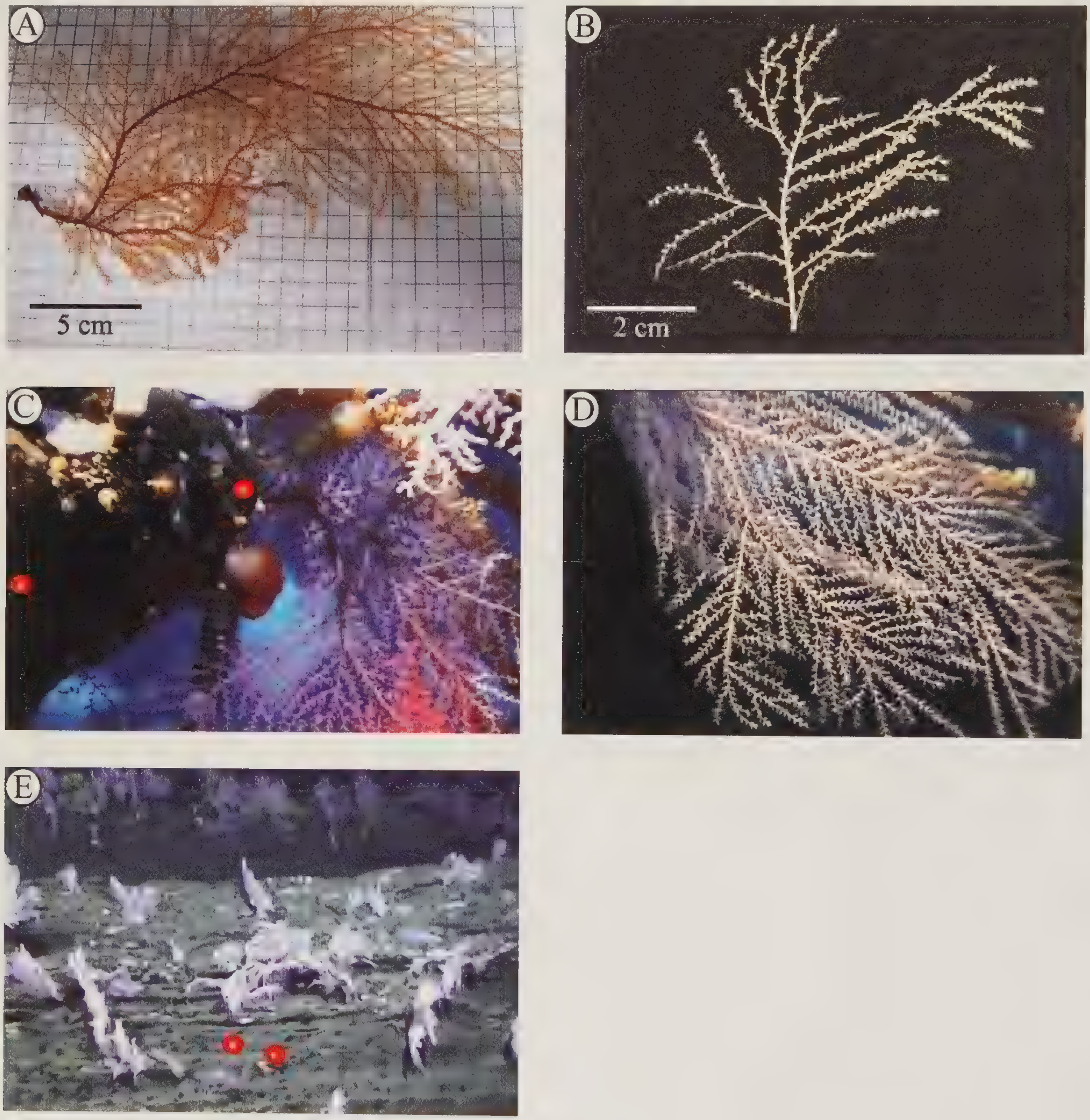


Figure 13-23

A map of the Aleutian Islands showing the distribution of *Plumarella spicata* (+) in Alaska waters.

Photos A) A fresh whole *P. spicata* colony (USNM 1134073) collected in northern Amchitka Pass, central Aleutian Islands, at a depth of 712 m. B) A dried branch of a *P. spicata* colony (USNM 1481803) collected in Adak Canyon, central Aleutian Islands, at a depth of 1746 m. C) A *P. spicata* colony (USNM 1134073) at the time of collection. D) A close-up view of the same specimen in photo C. E) A patch of *P. spicata* colonies on a siltstone ledge in Adak Canyon at a depth of 1745 m. The distance between the red laser marks in photos C and E is 10 and 20 cm, respectively.



22. *Plumarella superba* (Nutting, 1912)

Description (Adapted from Cairns, 2011a) Colonies branch in a plane, consisting of relatively few main branches that bear numerous rigid and wiry branchlets in a characteristic bottlebrush arrangement. The largest collected specimen is 26 cm in height and 32 cm in width, but colonies up to about 50 cm in height and width have been observed in situ. The axis is woody in texture and black in color. Small polyps (only 1.0–1.3 mm in length) occur on all sides of the branchlets in a crowded manner with 30–35 polyps/cm of branch length. The color of the coenenchyme is light to bright orange, occasionally creamy white in shallower-water specimens.

Each polyp is protected by eight opercular scales and eight rows of thick body wall scales; the sclerite formula is 5–7: 4–6: 3–4: 1–2. Opercular scales are lanceolate with a serrate margin. Marginal scales are triangular to prominently spinose with smooth (not keeled) inner surfaces. The remaining body wall scales are triangular with serrate margins; their outer face is either smooth or longitudinally ridged. Coenenchymal scales are irregular in shape but elongate and bear coarse granules.

Remarks This species was originally described in the genus *Primnodendron* and later transferred to *Thouarella*, probably because of its bottlebrush-arranged branchlets. Cairns (2011a) ultimately transferred it to *Plumarella* based on the lack of keels on its marginal scales. It is one of only two species in the genus that has bottlebrush-arranged branchlets (see Remarks of *Plumarella nuttingi*). It is also compared to *P. aleutiana* in that account, and is keyed by Cairns (2011a).

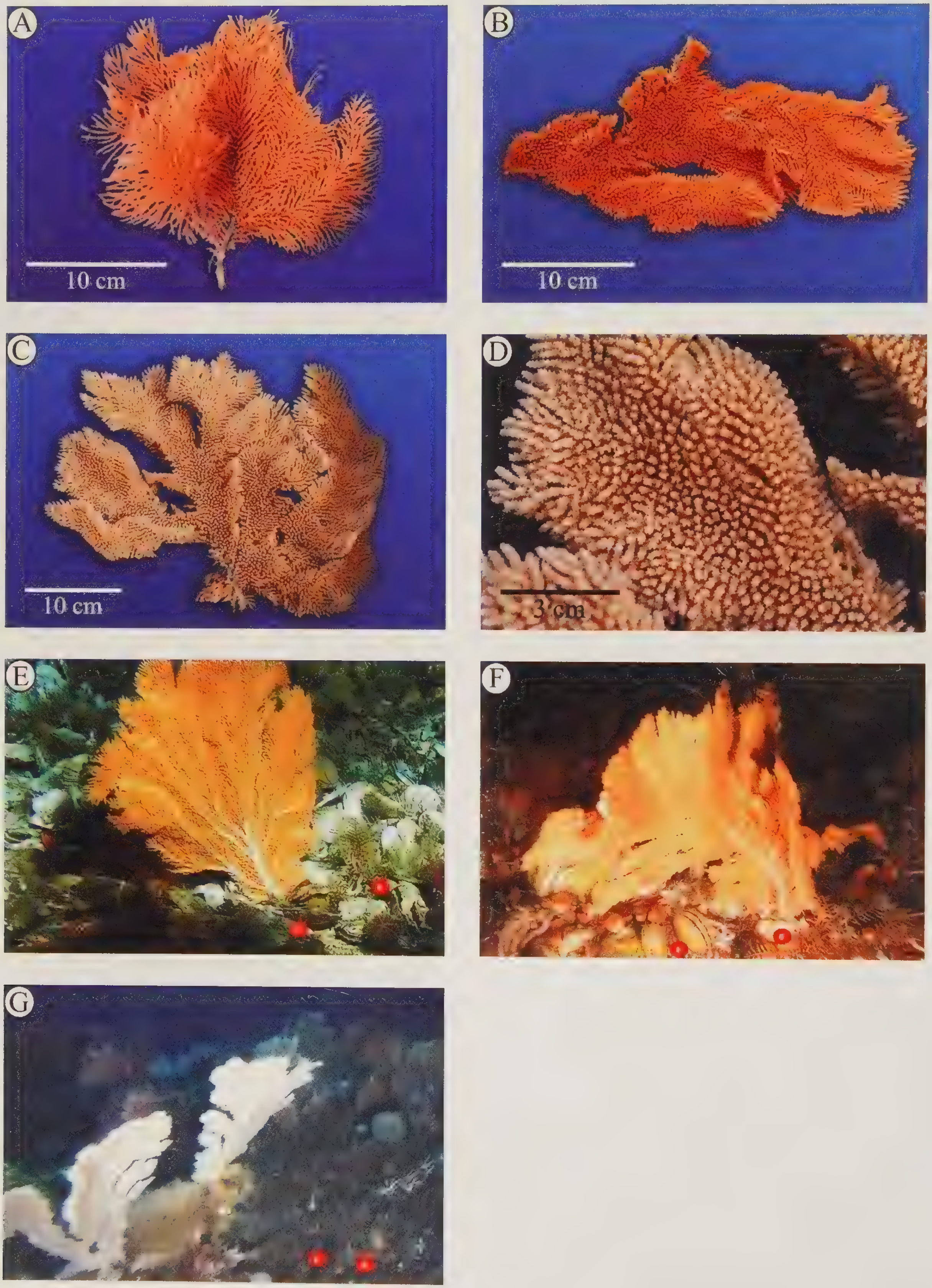
The microbial ecology of this species has been studied from specimens collected in the central Aleutian Islands (Gray et al., 2011). Colonies often host ophiuroid associates.

Distribution Locally common and relatively widespread. In Alaska – Aleutian Islands north of Umnak Island to southeast of Agattu Island including Petrel Bank (Fig. 13-24). There is a single record from deep water (1258 m) in Pribilof Canyon, eastern Bering Sea, collected with a beam trawl by the U.S. Fisheries Steamer *Albatross* in 1893. Given the geographical and bathymetric separation from all other records, we highlight this record as suspicious, possibly a translocation by the sampling gear. Elsewhere – this is the only Alaska *Plumarella* species found outside of Alaska. There is a single record (Institute of Marine Biology Institute FEB RAS; Vladivostok, Russia; MIMB 16534) from the Sea of Okhotsk, Russia (Dautova, 2007).

Habitat In Alaska – typically occurs in patches but occasionally singly on bedrock, boulders, cobbles, and pebbles at depths between 40 and 715 m. Elsewhere – found at a depth of 29 m.

Photos A) A fresh whole *P. superba* colony (USNM 1481810) collected on the Adak Canyon shelf, central Aleutian Islands, at a depth of 155 m. B) Fresh branches of a *P. superba* colony (USNM 1011276) collected near Little Tanaga Island, central Aleutian Islands, at a depth of 79 m. C) A fresh, large portion of a *P. superba* colony (USNM 1011277) collected on Petrel Bank, central Aleutian Islands, at a depth of 40 m. D) A close-up view of the same specimen in photo C. E) A *P. superba* colony (USNM 1135287) collected near Little Tanaga Island at a depth of 100 m. F) A *P. superba* colony (USNM 1134749) collected near Little Tanaga Island at a depth of 138 m. G) A *P. superba* colony (USNM 1011277; at center) in a patch of *P. superba* on Petrel Bank at a depth of 40 m. The distance between the red laser marks in photos E–G is 10 cm.

22. *Plumarella superba* (Nutting, 1912) (continued)


A
10 cm
B
10 cm
C
10 cm
D
3 cm
E
F
G

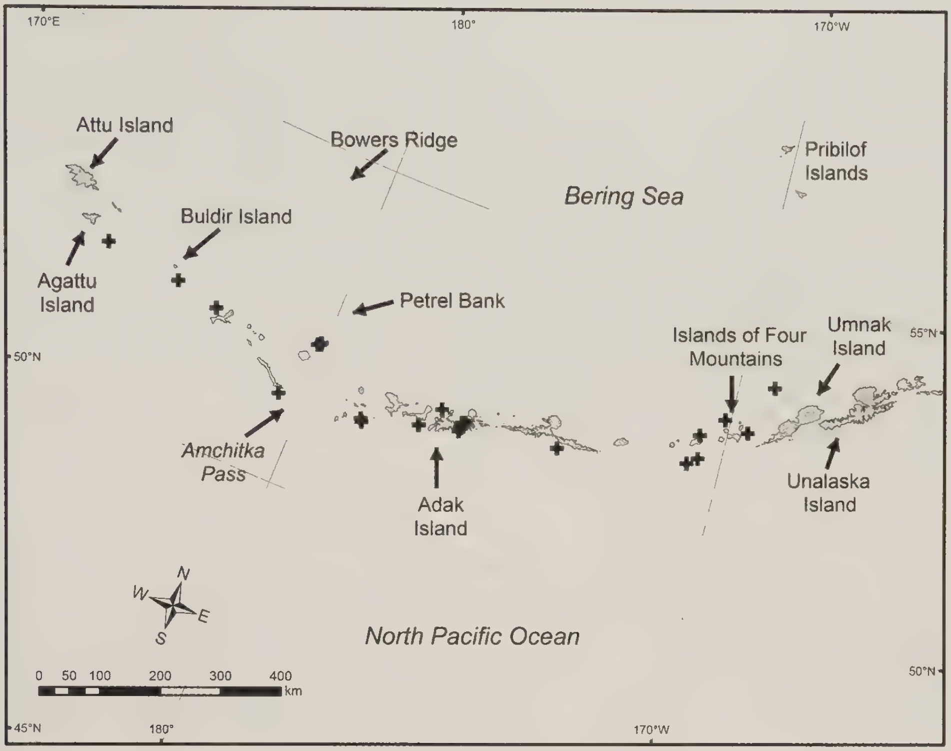

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Agattu Island
Petrel Bank
Islands of Four Mountains
Umnak Island
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 13-24

A map of the Aleutian Islands showing the distribution of *Plumarella superba* (+) in Alaska waters.

23. *Primnoa pacifica* Kinoshita, 1907

Description (Adapted from Cairns and Bayer, 2005) Colonies branch in a plane or are slightly bushy and dichotomously branched. The axis is rather stiff and extremely stout in large colonies. The height and width are typically to 1–2 m but 5 m or more in exceptional specimens. Polyps are stout and large (5.0–6.5 mm in length) and occur on all sides of the branches. The color of the axis is typically golden to dark brown but is often heavily calcified in larger colonies. The color of the coenenchyme is light pink or orange to bright orange and occasionally creamy white in the eastern Gulf of Alaska (Bowie Seamount, British Columbia, to the Fairweather Ground; less common in the northern part of that range).

Each polyp is protected by eight opercular scales; one pair of basal scales; a variable number of unpaired, fusiform medial scales; and eight marginal scales. The adaxial side of the polyp is naked. Basal scales are massive, each bearing a robust horn-like distal spine. The medial scales occur on the abaxial and lateral sides of the polyps and are usually much smaller than the basal and buccal scales. There are five large marginal scales in the abaxial and lateral positions, and three much smaller marginals in the adaxial position. Opercular scales are lanceolate to tongue-shaped and bear multiple ridges on their inner face. Coenenchymal scales are elongate and round in cross section and up to 1.5 mm in length.

Remarks This robust species was described and illustrated by Cairns and Bayer (2005), who also provide a key to all species in the genus.

Primnoa pacifica, also known as "red tree corals," are the most ecologically important cold-water corals in the North Pacific Ocean. Red tree corals are the largest and most geographically widespread corals in the region and provide important habitat for myriad species including commercially important fish and crabs (Stone et al., 2015b). They are consequently the most studied cold-water coral in the region and quite possibly the world. Studies have been done on their ecology (Krieger, 2001; Krieger and Wing, 2002; Du Preez and Tunnicliffe, 2011; Stone et al., 2015b; Masuda and Stone, 2015; Hartill et al., 2020), reproduction (Waller et al., 2014, 2019), growth (Andrews et al., 2002; Matsumoto, 2007; Williams et al., 2007; Aranha et al., 2014; Choy et al., 2020), genetics (Morrison et al., 2015), microbial ecology (Goldsmith et al., 2018), and the effects of ocean warming (Stone and Mondragon, 2018; Johnstone et al., 2021) and ocean acidification (Rossin et al., 2019).

Red tree corals are one of only a few octocoral species worldwide documented to display deep-sea emergence, a phenomenon whereby organisms that typically dwell in the deep sea are able to exist in shallow-water areas because of unusual oceanographic conditions there. Emergence has been documented in glacial fjords to depths of 6 m in Holkham Bay and 9 m in Glacier Bay, Southeast Alaska (Stone and Mondragon, 2018), and 12 m in Knight Inlet, northern Vancouver Island, British Columbia (McDaniel[6]).

Their tolerant temperature range is approximately 0.2–7.5°C (Matsumoto, 2007; Stone and Mondragon, 2018) but they may tolerate temperatures near 10°C for several days (Stone and Mondragon, 2018). They are fairly euryhaline and able to tolerate salinities as low as 26.9 for several days or more. They are preyed upon by calliostomatid snails (*Akoya platinum*), nudibranchs (*Tritonia tetraquetra*), and the spiny red sea star (*Hippasteria phrygiana*) (Stone et al., 2015b). Associated fauna of colonies residing in shallow water include the shrimps *Lebbeus groenlandicus*, *Eualus butleri*, *E. suckleyi*, and *E. townsendi*. Several fish species, including the goldeneye snailfish (*Allocareproctus unangas*), lay their egg masses on red tree coral colonies (Busby et al., 2006).

The coenenchyme including the sclerites is composed of high-magnesium calcite (8.1–8.3 mol% $MgCO_3$), whereas the carbonate mineralogy of the skeletal axis and holdfast are more variable, ranging from principally high-magnesium calcite (10.7–14.4 mol% $MgCO_3$) to principally aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Common, very abundant locally, and widespread (Fig. 13-25). In Alaska – eastern GOA including the inside waters of Southeast Alaska, western GOA including the inside waters of Prince William Sound, Aleutian Islands (Samalga Pass to Buldir Reef), and a single record from Zhemchug Canyon in the eastern Bering Sea. Conspicuously absent from the Gulf of Alaska Seamount Province but likely present on Dickens Seamount, the easternmost seamount in the Province; see *Primnoa pacifica* var. *willeyi* (Hickson, 1915) species account. Elsewhere – this species appears to be relatively common in northern British Columbia (Alaska border to west of Queen Charlotte Sound) where it forms thickets and then uncommon south to northern Washington. In 2018, small patches of *P. pacifica* were discovered just south of the Oregon–California border and off Punta Gorda at depths between 362 and 582 m (Everett[5]). There is a single confirmed record (USNM 57557) from off Point La Jolla in southern California collected by the U.S. Fisheries Steamer *Albatross* in 1904. The record is so geographically disjunct and in an area of atypical habitat for the species that we suspect

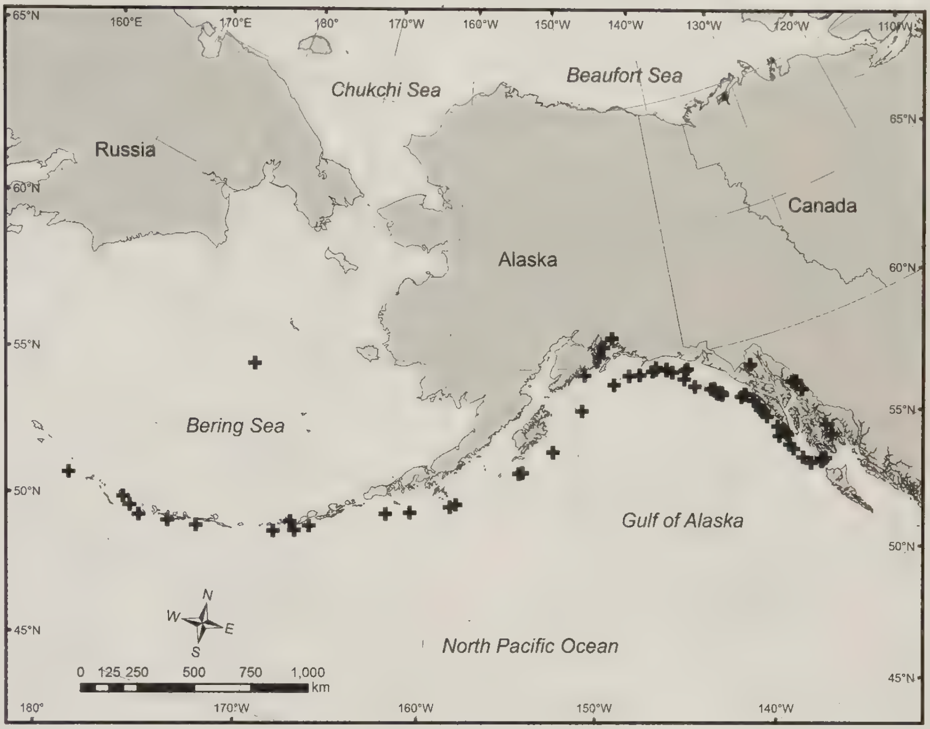


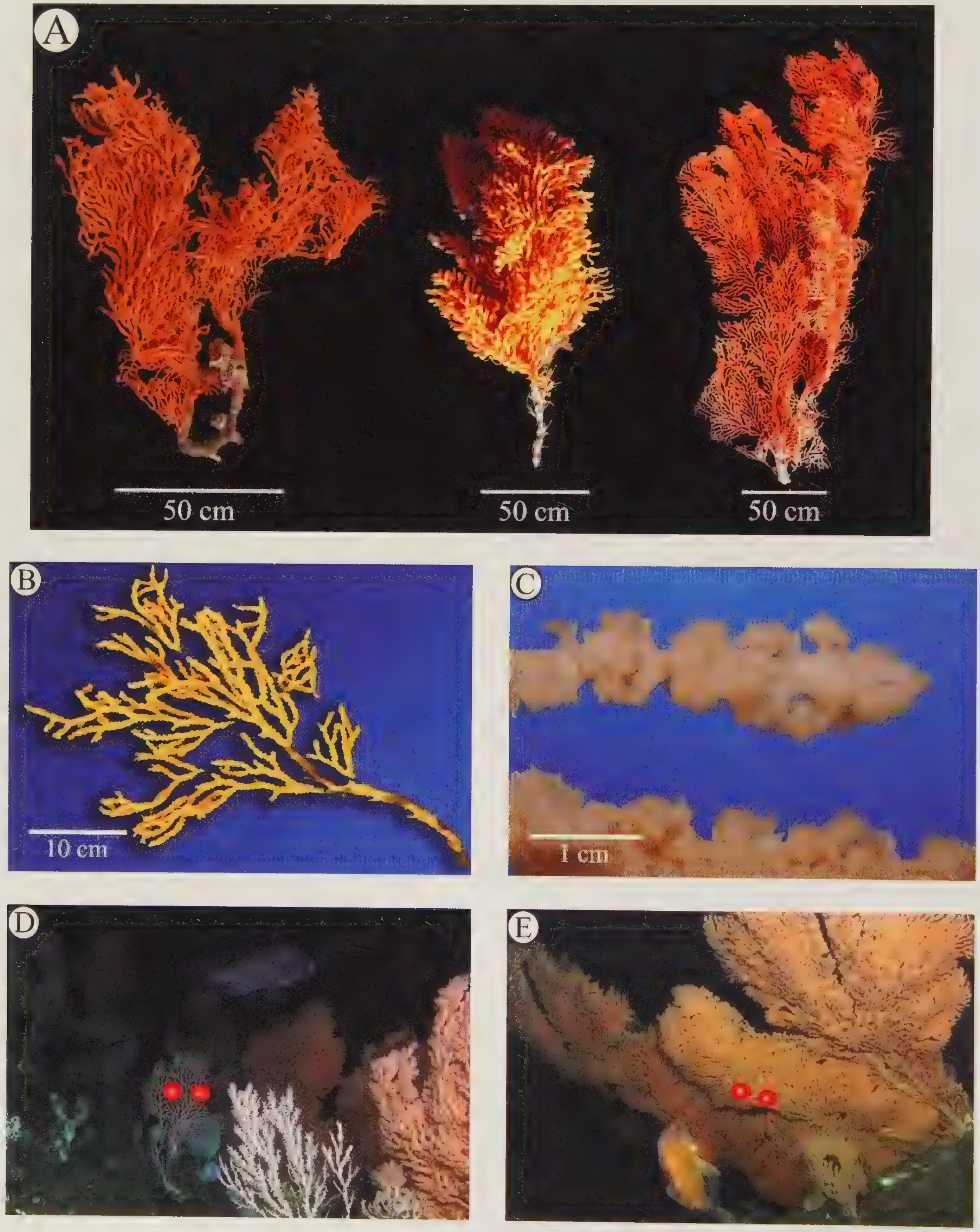
Figure 13-25

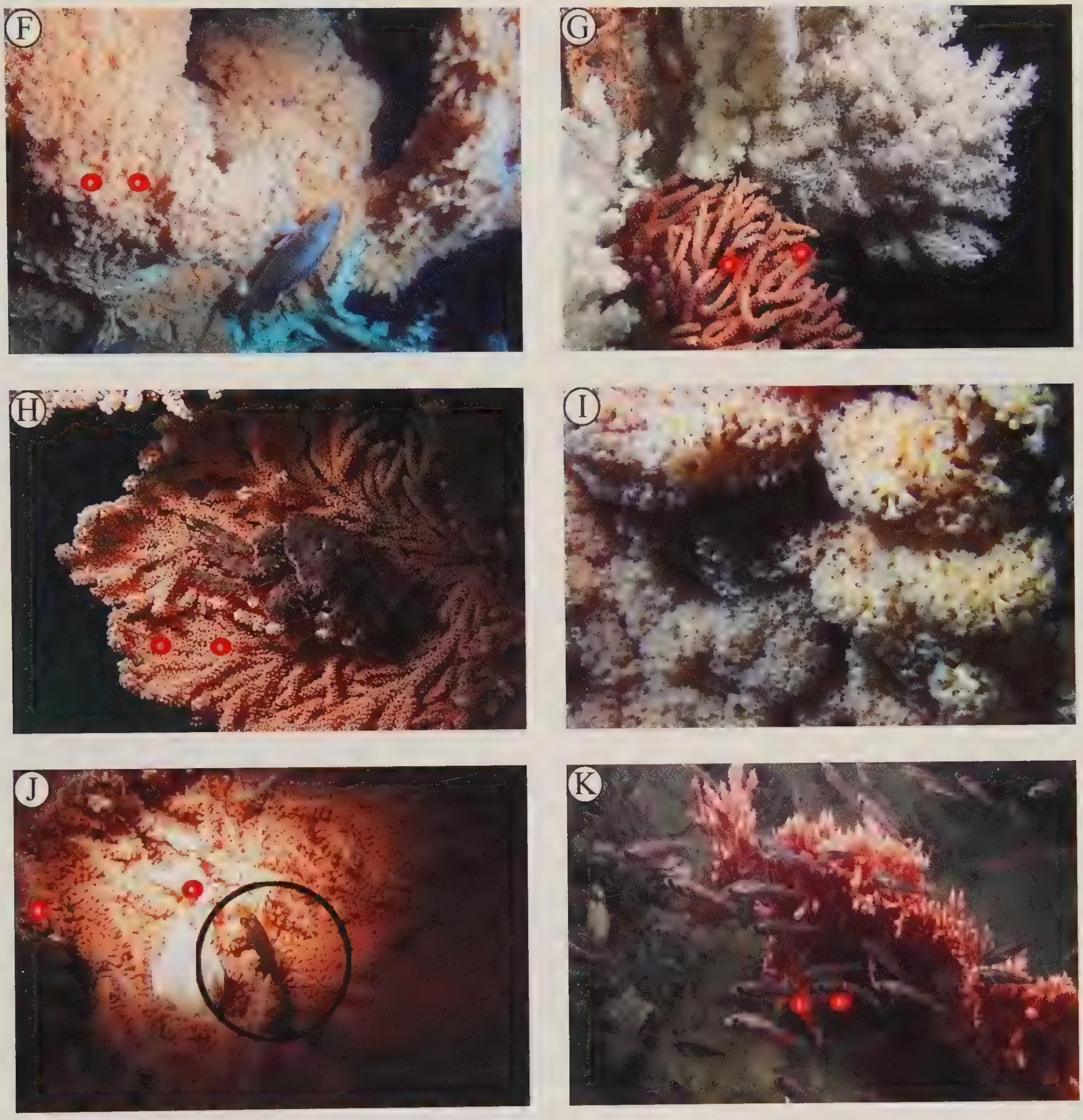
A map of the North Pacific Ocean showing the distribution of *Primnoa pacifica* (+) in Alaska waters.

the specimen was translocated by a fishing vessel. In the western Pacific Ocean the species ranges to the Sea of Japan including the Bay of Peter the Great, Russia, and west of Honshu and Hokkaido Islands including the Shiribeshi Seamount in Japan (Matsumoto, 2005). Kinoshita (1907) described the type specimen from Sagami Bay (600 m depth) near Tokyo on the Pacific Ocean side of Honshu Island, and Broch (1935) later reported a specimen from the Sea of Okhotsk, Russia.

Habitat In Alaska – generally occurs in thickets that are often extensive in the eastern GOA. Occurs singly on glacial erratics also known as drop stones (i.e., boulders dropped as glaciers or icebergs melt away in the ocean). Grows on bedrock, boulders, and large cobbles in areas with moderate current. Also known to grow on derelict fishing gear including steel trawl cables; such occurrences may provide a timeline of settlement from which age and growth can be estimated (Krieger, 2001). Found at depths between 6 and 640 m but video observations from the central Aleutian Islands indicate that this species may occur as deep as 899 m there (Stone, 2014). Elsewhere – reported from bedrock and boulder habitats at depths between 12 m in Knight Inlet, northern Vancouver Island, British Columbia, and 1250 m in the Sea of Japan, Russia.

Photos A) Three large *P. pacifica* specimens collected in the eastern GOA. Left: a fresh major branch from an irregular colony collected in Dixon Entrance at a depth of 320 m. The branch was damaged at the base by fishing gear. Center: a fresh bushy colony collected in Dixon Entrance at a depth of 335 m. The colony was damaged at the base by fishing gear. Right: a fresh uniplanar but multi-fanned colony collected on the Fairweather Ground at a depth of 163 m. B) A large dried branch complex from a *P. pacifica* specimen (USNM 1481839) collected on Portlock Bank, western GOA, at a depth of 326 m. C) A close-up view of a fresh branch from a *P. pacifica* specimen (USNM 1116849) collected in Zhemchug Canyon, eastern Bering Sea, at a depth of 520 m. D) A school of yellowtail rockfish (*Sebastes flavidus*) feeding in a thicket of *P. pacifica* in Dixon Entrance at a depth of 165 m. E) A yelloweye rockfish (*S. ruberrimus*) taking shelter near large *P. pacifica* colonies on the Shutter Ridge, eastern GOA, at a depth of 160 m. F) A silvergray rockfish (*S. brevispinis*) resting on a large *P. pacifica* colony on the Fairweather Ground at a depth of 170 m. G) The white color-phase of *P. pacifica* on the Shutter Ridge, eastern GOA, at a depth of 203 m. H) A blue king crab (*Paralithodes platypus*) resting on a *P. pacifica* colony in Tracy Arm in Holkham Bay, Southeast Alaska, at a depth of 18 m. I) A close-up view of a *Primnoa pacifica* colony on the Shutter Ridge at a depth of 192 m. J) A young-of-the-year walleye pollock (*Gadus chalcogrammus*) (seen within the black circle) shelters in a *Primnoa pacifica* colony in Tracy Arm, Holkham Bay, at a depth of 20 m. K) A school of juvenile (one-year old) walleye pollock feeding on euphausiids (likely *Thysanoessa raschii*) that are swarming around *P. pacifica* in Glacier Bay, Southeast Alaska, at a depth of 156 m. The distance between the red laser marks in photos D–H, J, and K is 10 cm.




F
G
H
I
J
K

24. *Primnoa pacifica* var. *willeyi* (Hickson, 1915)

Description See Remarks.

Remarks Variety *willeyi*, considered to be the same species as *P. pacifica*, differs from typical colonies in having more slender and often twisted polyps that are somewhat constricted at mid-height, thus seeming to support an overly large distal portion of the polyp. Also, they tend not to have medial scales on the lateral sides of their polyps. The variety is described and illustrated by Cairns and Bayer (2005).

Associated fauna include pleustid and stenothoidid amphipods (Watling and Stone[7]) and ophiuroids. The skeletal axis is composed of high-magnesium calcite (14.8 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon but widespread. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, western Gulf of Alaska, central and western Aleutian Islands (Amchitka Pass), and a single collected specimen along with several video observations from Dickens Seamount in the Gulf of Alaska Seamount Province (Fig. 13-26). Elsewhere – there are two records from Chatham Sound, British Columbia, immediately south of Southeast Alaska.

Habitat In Alaska – occurs singly or in small thickets with *P. pacifica* on bedrock and boulders at depths between 27 and 863 m. Elsewhere – no information available.

Photos A) A dried branch of a *P. pacifica* var. *willeyi* colony (USNM 1115515) collected on Amchixtam Chaxsxii in Amchitka Pass, central Aleutian Islands, at a depth of 863 m. B) A close-up view of the same specimen in photo A. C) The same colony in photo A just prior to collection. D) A close-up view of the same colony in photo C. E) A *P. pacifica* var. *willeyi* colony (USNM1075478) collected on Dickens Seamount at a depth of 758 m. F) A close-up view of the same colony in photo E. The distance between the red laser marks in photos C–E is 10 cm.

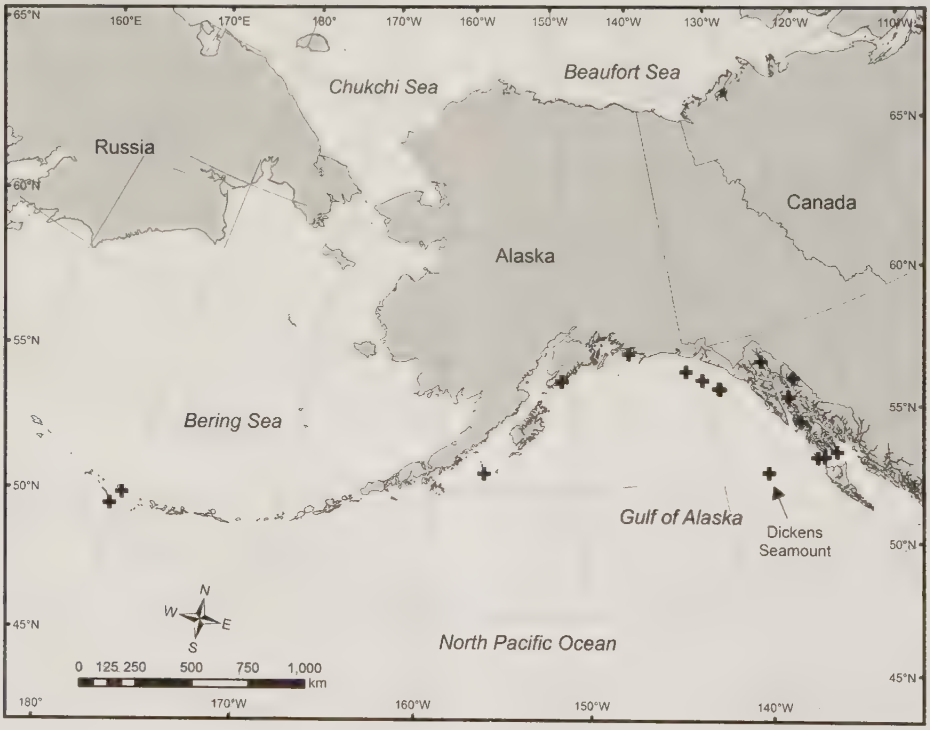
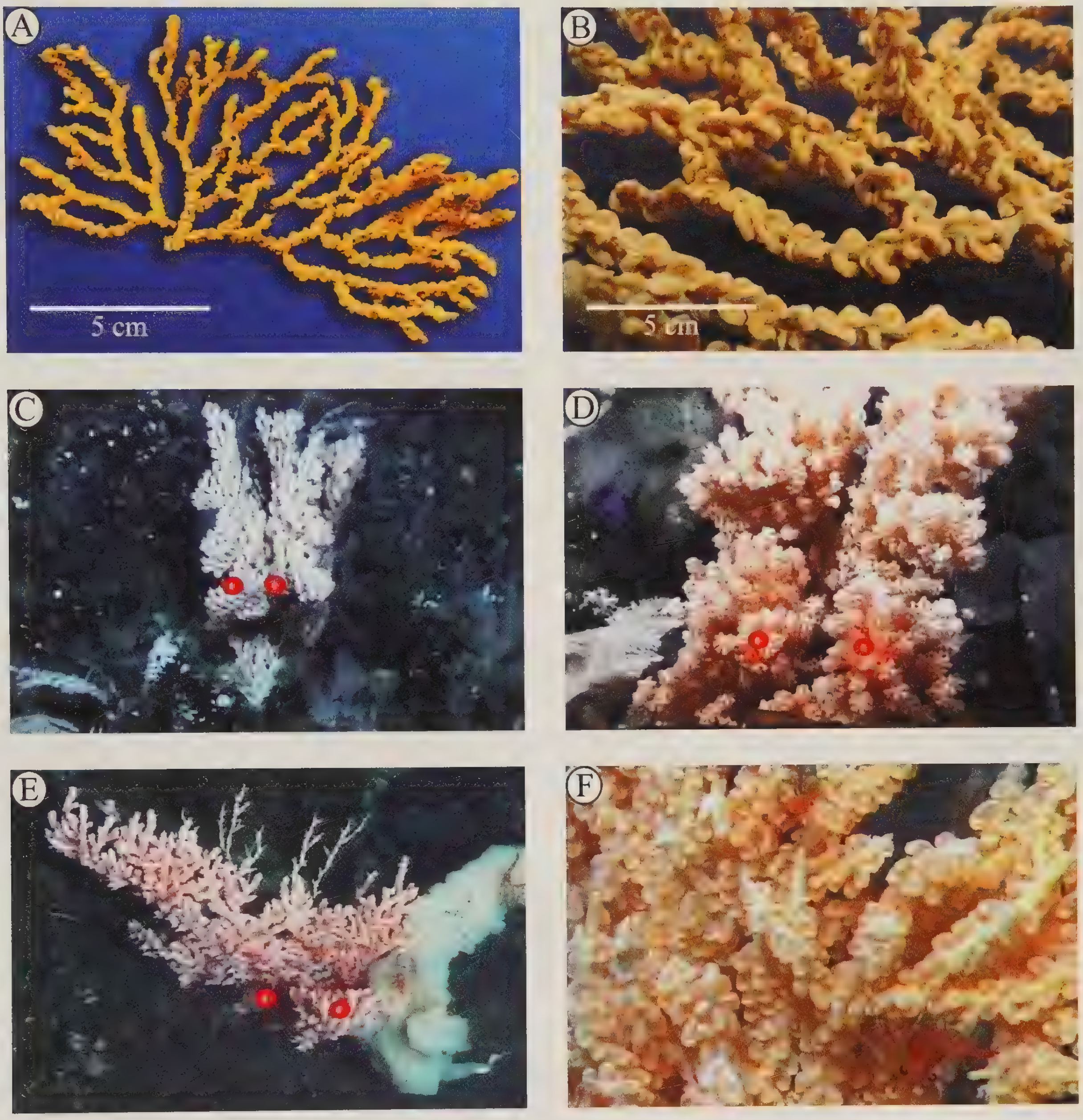

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
Dickens Seamount
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 13-26

A map of the North Pacific Ocean showing the distribution of *Primnoa pacifica* var. *willeyi* (+) in Alaska waters.


A
5 cm
B
5 cm
C
D
E
F

25. *Primnoa wingi* Cairns and Bayer, 2005

Description (Adapted from Cairns and Bayer, 2005) Colonies branch in a uniplanar or sometimes bushy and dichotomous manner. The largest colonies approach 1 m in height and width. The color of the axial skeleton is golden brown, occasionally with thin black streaks. Polyps are densely arranged on branches and most are directed downward, but some curve or corkscrew in different directions. Polyps are elongate, slender but fleshy, large (up to 12 mm in length, twice the size of *P. pacifica* polyps), and support a bulbous apical tip. The coenenchyme is bright orange to reddish-orange in life and a lighter orange when dried.

Each polyp is protected by eight opercular scales; a variable number of unpaired, fusiform medial scales; and eight large marginal scales. The adaxial side of the polyp is naked. Medial body wall sclerites are elongate and slender, occurring in a thin strip on the abaxial polypar side, and sunken into the polyp tissue; no definable basal scales are present. Marginal scales are quite large and convex, forming a prominent collar that envelopes the lower part of the opercular scales. The opercular scales are unique in shape, being elongate, medially constricted, and spatulate distally; their outer face is often ridged. The coenenchymal scales are elongate, slender, and similar to the body wall scales in shape.

Remarks *Primnoa wingi* differs from other species in the genus by having inconspicuous body wall scales that are immersed in the fleshy polyp tissue, spatulate opercular scales, and highly concave marginal scales. All species are keyed in Cairns and Bayer (2005).

Primnoa wingi is typically found in complex habitats and is an excellent indicator species of coral garden habitat. *Primnoa wingi*, along with *Parastenella gymnogaster*, are the only two corals found both in Alaska waters and on the Emperor Seamounts in the central-west Pacific Ocean.

Associated fauna include stenothoidid amphipods (Watling and Stone[7]). The axial holdfast is composed of high-magnesium calcite (8.5 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – Amukta Pass to southwest of Attu Island in the Aleutian Islands and Zhemchug Canyon in the eastern Bering Sea (Fig. 13-27). Elsewhere – there is a single record from Nintoku

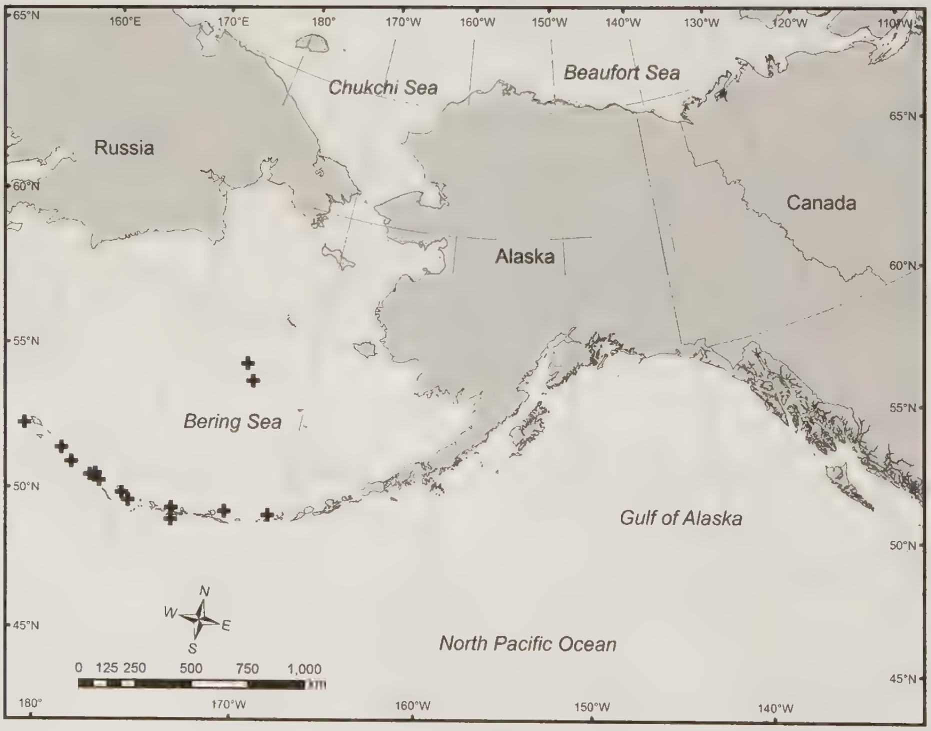


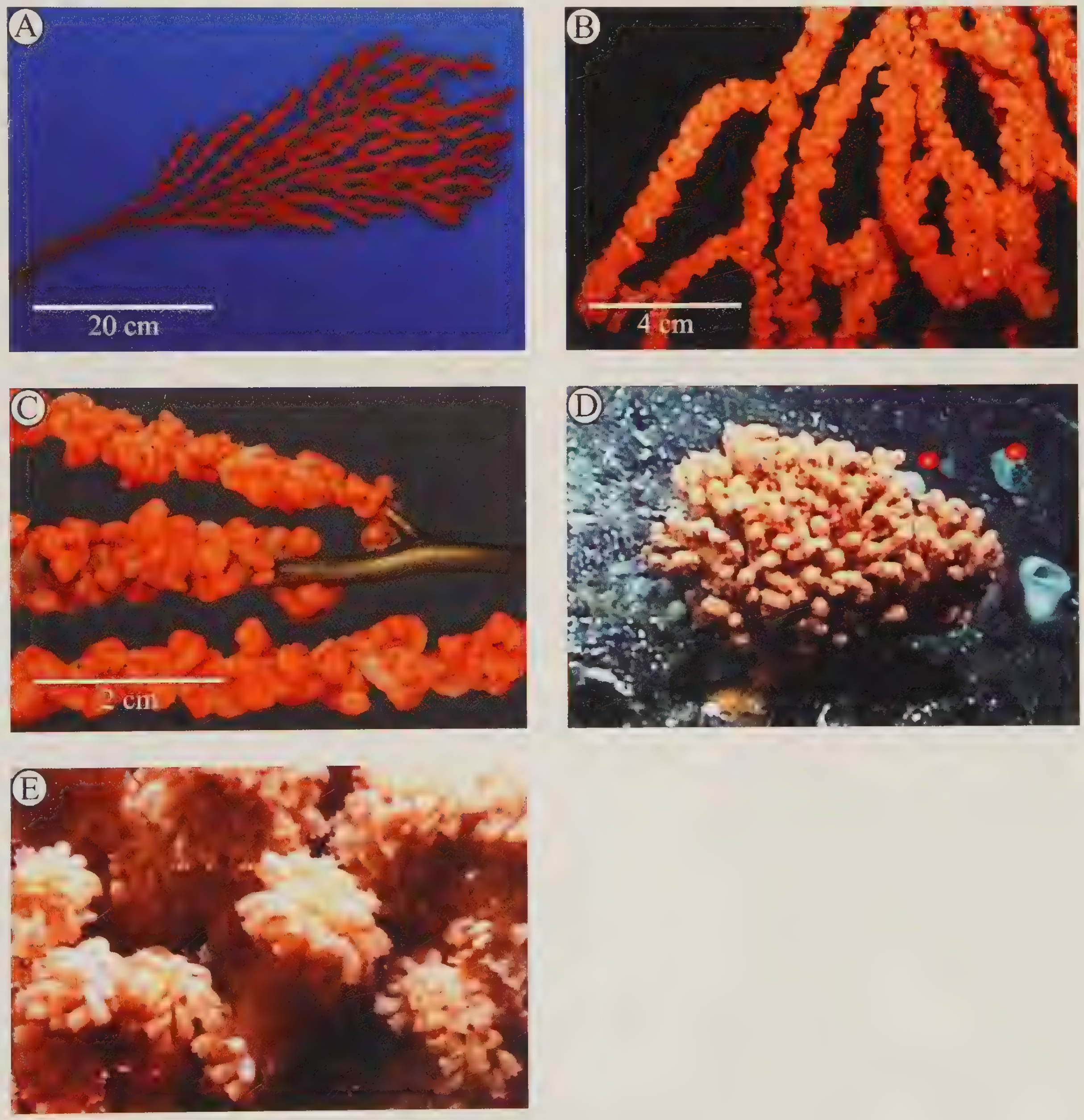
Figure 13-27

A map of the North Pacific Ocean showing the distribution of *Primnoa wingi* (+) in Alaska waters.

Seamount in the Emperor Seamounts, central-west Pacific Ocean.

Habitat Occurs singly or in small patches on bedrock and boulders at depths between 217 and 914 m. Video observations from the central Aleutian Islands indicate that this species may occur as deep as 1280 m there (Stone, 2014). Elsewhere – found at a depth of 1156 m.

Photos A) A fresh whole *P. wingi* colony (USNM 1115519) collected in northern Amchitka Pass, central Aleutian Islands, at a depth of 711 m. B) A close-up view of a fresh large branch of a *P. wingi* colony (USNM 1116847) collected in Zhemchug Canyon, eastern Bering Sea, at a depth of 914 m. C) A close-up view of the same specimen in photo B. D) A bushy *P. wingi* colony observed on Amchixtam Chaxsxii in Amchitka Pass, central Aleutian Islands, at a depth of 1280 m. The distance between the red laser marks is 10 cm. E) A close-up view of the same colony in photo D.



26. *Thouarella cristata* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies branch primarily in a plane, consisting of a few main branches from which branchlets originate in a loose pinnate manner. The presence of an unidentified commensal polychaete that forms a tube along the axis of the main branches may occasionally induce a third set of branchlets to occur, forming a bushy or even bottlebrush arrangement. The largest known colony is 50 cm in height. Polyps occur on all sides of the branchlets in a crowded manner with 24–26 polyps/cm. Polyps are 1.7–2.5 mm in length and brooding polyps are common. The axis is pale yellow to dark brown; the coenenchyme is light orange to bright orange in life and fading to lighter orange in ethanol and when dried.

Each polyp is protected by eight opercular scales and eight rows of thick body wall scales; the sclerite formula is 6–9: 6–7: 4–6: 3–4. Additional small elliptical scales are also present on the adaxial surface. The marginal scales are pointed and both the outer and inner surfaces are prominently ridged (the innermost surface is keeled). The coenenchymal scales are irregular in shape, usually elongate, and up to 0.9 mm in length. All scales are thick and robust.

Remarks Twenty-five species of *Thouarella* were monographed and keyed by Taylor et al. (2013) but unfortunately *T. cristata* was overlooked in their account. This species is however included in a recent account of all 35 known species in the genus (Cairns, 2021). *Thouarella cristata* is distinctive in having thick, highly ridged body wall scales and a quasi-bottlebrush arrangement of branchlets.

In order to observe the ridging on the inner face of the marginal scales, which is diagnostic of the genus, the polyps must first be bleached to disarticulate the sclerites, and then the sclerites can be examined at 50–100× power under a microscope. Dyeing the dry sclerites with a colored marker elucidates the feature.

Associated fauna include polynoid polychaetes (Watling and Stone[7]) and ophiuroids. The skeletal axis is composed of high-magnesium calcite (12.7 mol% $MgCO_3$; senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon but locally abundant. In Alaska – Aleutian Islands (Adak Island to Kiska Island) including Petrel Bank (Fig. 13-28). Elsewhere – not reported.

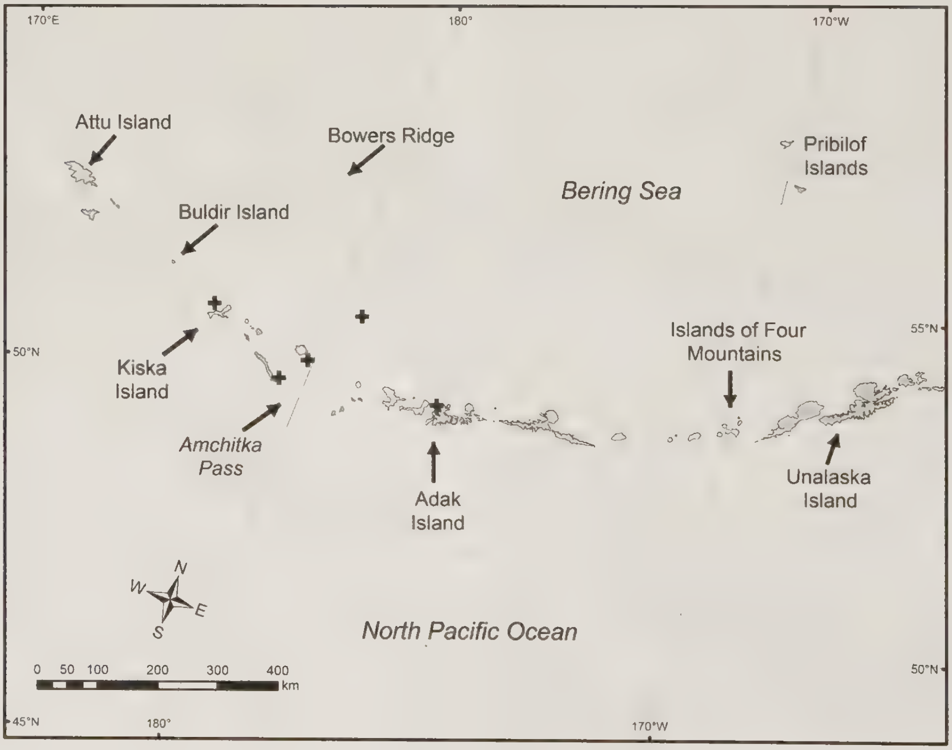
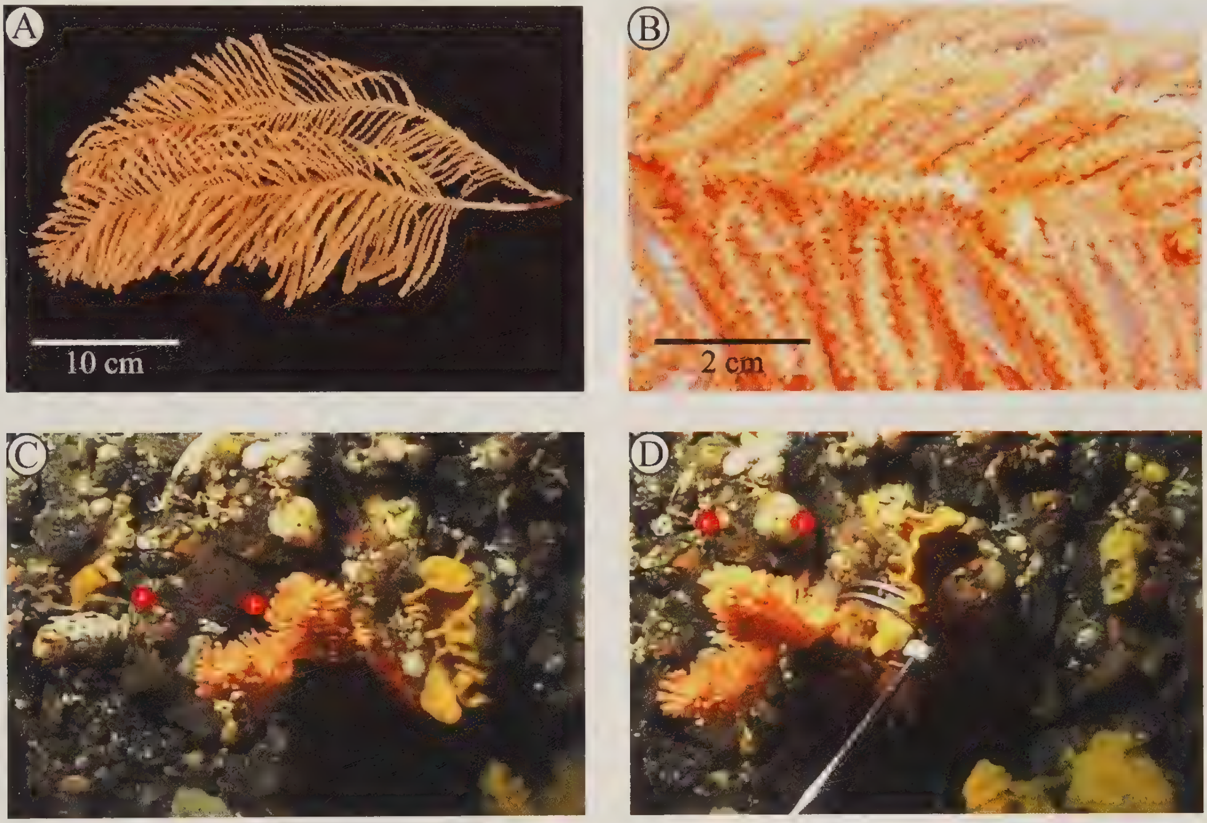


Figure 13-28

A map of the Aleutian Islands showing the distribution of *Thouarella cristata* (+) in Alaska waters.

Habitat Occurs singly or in patches with the congener *T. trilineata* on boulders, cobbles, pebbles, and occasionally bedrock at depths between 91 and 744 m.

Photos A) The dried *T. cristata* holotype (USNM 1115600; large branch complex) collected on Petrel Bank, central Aleutian Islands, at a depth of 154 m. B) A close-up view of the same specimen in photo A when it was fresh. C) A view (from above) of the holotype in situ. D) A view of the holotype during collection. The distance between the red laser marks in photos C and D is 10 cm.



27. *Thouarella trilineata* Cairns, 2011

Description (Adapted from Cairns, 2011a) Colonies branch primarily in a plane, consisting of a few main branches from which branchlets originate in three rows, giving the colony a bushy to bottlebrush appearance; commensal polychaetes are absent. The largest collected colony is 23 cm in height. Polyps occur on all sides of the branchlets in a crowded manner with 35–40 polyps/cm. Polyps are 1.4–1.7 mm in length and brooding polyps are absent. The axis is pale yellow; the coenenchyme is light orange to bright orange in life, fading to lighter orange in ethanol and when dried.

Each polyp is protected by eight opercular scales and eight rows of thick body wall scales; the sclerite formula is 5–6: 4–6: 3–5: 1. Additional (6–10) small, randomly arranged elliptical scales are also present on the adaxial surface. The marginal scales are pointed and both their outer and inner surfaces are prominently ridged (the innermost surface is keeled), however the adaxial marginals are not spinose. Coenenchymal scales are irregularly shaped, elongate, and up to 0.6 mm in length.

Remarks *Thouarella trilineata* is quite similar to *T. cristata*, but differs in lacking the polychaete commensal, and in having trilinear rows of branchlets, smaller polyps, and non-spinose adaxial marginal scales.

Ophiuroids are common associates of this coral, and they are often the same color as the coenenchyme.

Distribution Uncommon but locally abundant. In Alaska – Aleutian Islands from Unalaska Island to Amchixtam Chaxsxii (Fig. 13-29). Elsewhere – not reported.

Habitat Occurs singly or in patches with the congener *T. cristata* on boulders, cobbles, pebbles, and occasionally bedrock at depths between 97 and 1266 m.

Photos A) A preserved (in ethanol) whole *T. trilineata* colony (USNM 1009943; paratype) with associated ophiuroids collected near Amlia Island, central Aleutian Islands, at a depth of 198 m. B) A close-up view of the same specimen in photo A with associated ophiuroid (indicated by the black circle). C) The preserved (in ethanol) *T. trilineata* holotype (USNM 1010175; whole

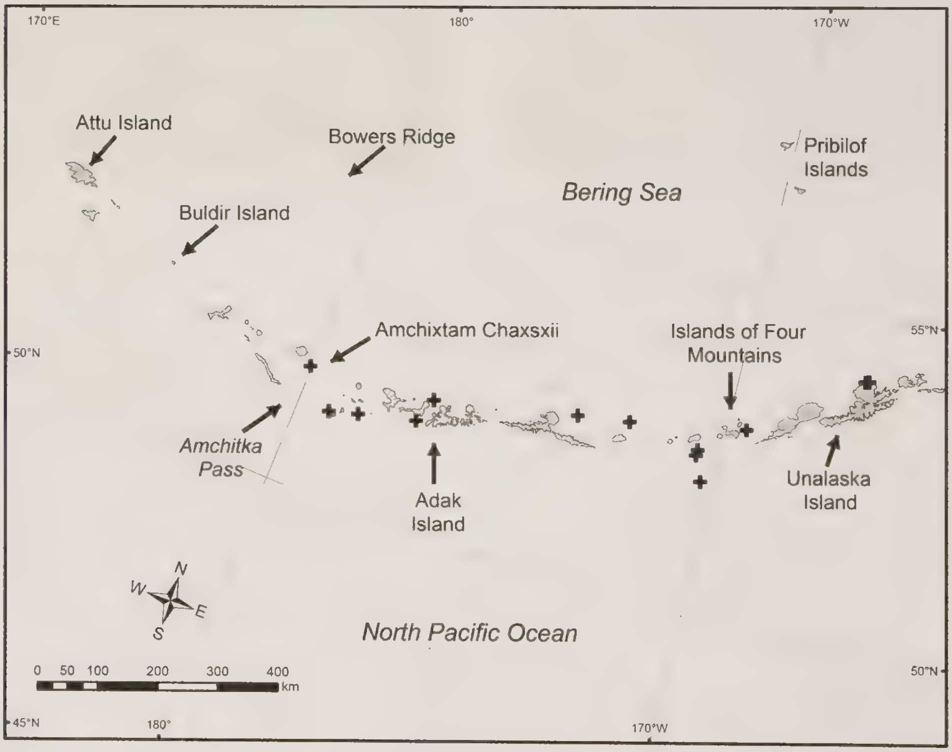
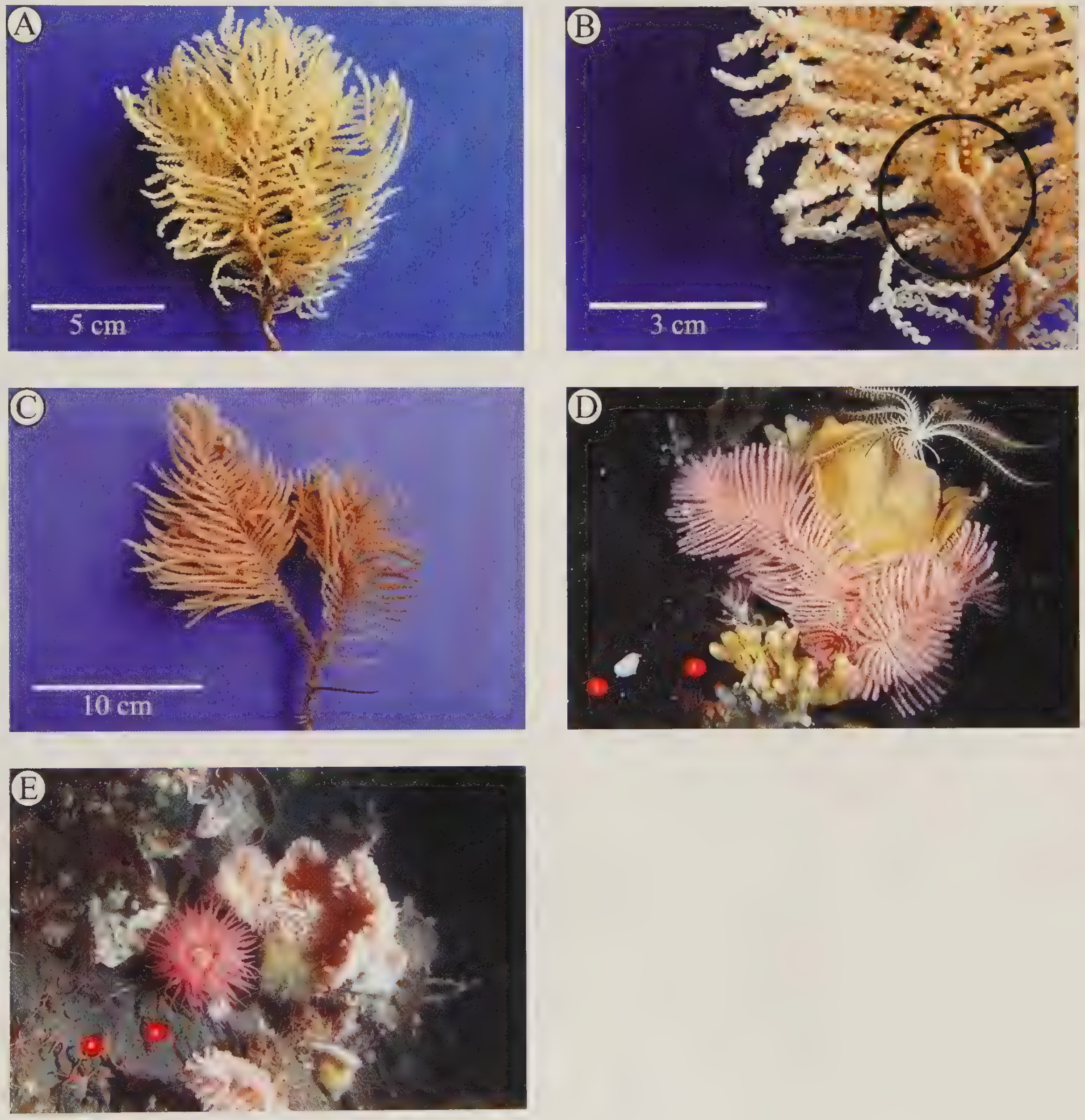


Figure 13-29

A map of the Aleutian Islands showing the distribution of *Thouarella trilineata* (+) in Alaska waters.

colony) collected near the Islands of Four Mountains, eastern Aleutian Islands, at a depth of 202 m. D) A *T. trilineata* colony photographed near Bobrof Island, central Aleutian Islands, at a depth of 160 m. E) *Thouarella trilineata* colonies photographed near Great Sitkin Island, central Aleutian Islands, at a depth of 175 m. The distance between the red laser marks in photos D and E is 10 cm.



CHAPTER 14

Family Sarcodictyonidae

(Adapted from McFadden et al., 2022) Sarcodictyonids are octocorals without a skeletal axis and with polyps connected basally by ribbon-like stolons that often fuse to form membranous expansions or mats. Polyps are monomorphic and the anthocodiae are retractile into prominent calyces that are typically evenly distributed over the mat. Lateral budding of primary polyps often produces daughter polyps. The entire colony is covered with a thin coenenchyme. Polyp sclerites are small blunt rods with ornamented tubercles and are sparse or often arranged in longitudinal rows but not in the arrangement of collaret and points. Sclerites throughout the rest of the colony are mostly stellate plates and crosses.

Of the two known genera of the recently erected family Sarcodictyonidae (McFadden et al., 2022), only *Sarcodictyon* is found in Alaska waters with one known species (*S. incrustans*) (Broch, 1935) and one other species yet described. *Sarcodictyon* was formerly included in the now defunct suborder Stolonifera. Madsen (1944) referred to the Stolonifera as the most heterogeneous group within the Octocorallia given their membranous growth form. *Sarcodictyon* are uncommon in Alaska waters and consequently have a limited distribution in the eastern Gulf of Alaska and on a few seamounts in the Gulf of Alaska Seamount Province (Fig. 14-1). The group is represented by only two taxa: one found in shallow water (15–238 m) and the other in deep water (2665–2881 m). Colonies encrust bedrock, and the bare skeletons of octocorals (*Primnoa pacifica*), barnacles, brachiopods, and hexactinellid sponges.

All Sarcodictyonidae specimens collected in Alaska waters should be retained and properly preserved for morphological and molecular studies.

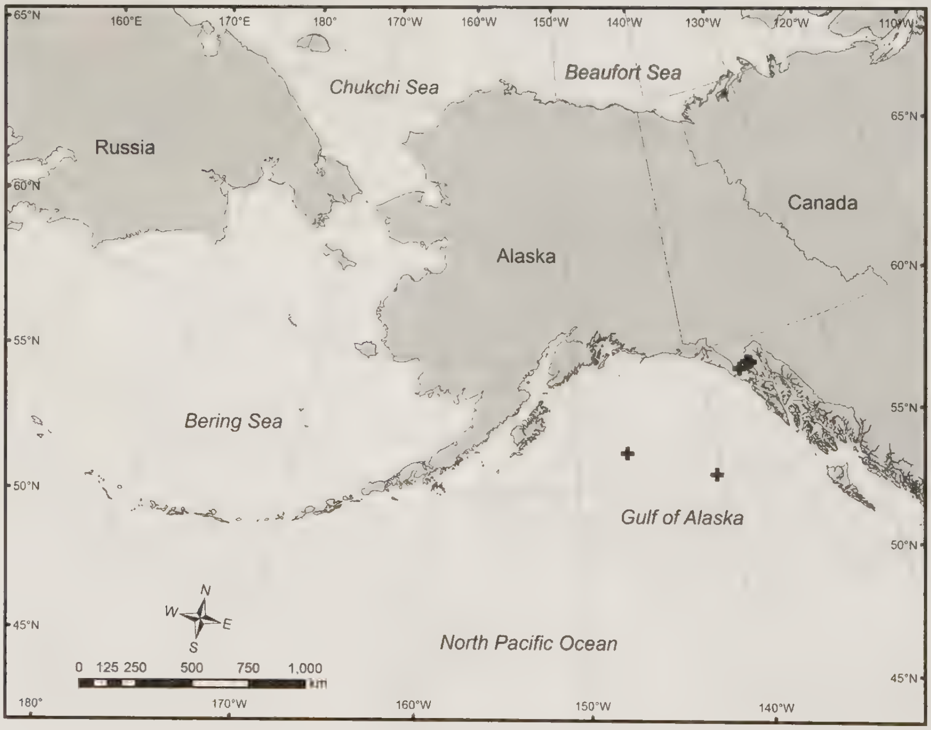

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 14-1

A map of the North Pacific Ocean showing the distribution of corals in the family Sarcodictyonidae (+) in Alaska waters.

1. *Sarcodictyon incrustans* (Broch, 1935)

Description (Adapted from Broch, 1935) Colonies form crust-like coatings on substrates, including one specimen that had completely overgrown an attached hydroid (*Tubularia* sp.) stalk and resembled a gorgonian similar to *Anthothela*. The stolon plate forms a continuous crust from which polyps are densely packed. The polyps are fully retractable into the coenenchyme and are 6 mm in height (without tentacles) and 3 mm in width. The arrangement of the polyp sclerites are similar to those of *Clavularia armata* but are smaller and have well-defined double rows with the middle sclerites arranged *en chevron* and converging upwards. The double rows are just above the polyp base and form the backs of the eight slightly raised longitudinal elevations of the polyp wall.

The aboral side of the tentacle trunk contains a platoon of longitudinally arranged sclerites (0.24–0.42 mm in length) that are irregularly rod-shaped with low warts or thorns. In the upper part of the polyps, the sclerites are the same size as those in the tentacles, but the warts are much more strongly developed. The polyp wall sclerites are 0.17–0.37 mm in length and the lower polyp sclerites are slightly shorter (0.17–0.23 mm in length) derelict clubs. Sclerites are densely packed everywhere but especially in the stolon where they are the largest (0.17–0.70 mm in length) and consist of slender but quite strong, heavily thorned spindles (0.50–0.60 mm in length) and slender clubs (0.25–0.30 mm in length) with strong thorns on one side and weak on the other.

The contraction of the polyps begins with the placement of the tentacles over the mouth disc. Accordingly, the polyp wall folds in the middle, and the distal part of the polyp is drawn into the lower half by inserting the polyp wall. One could believe that a calyx was present; however, the indentation continues until the whole polyp is retracted (or rather "indented") into the coenosarc and can only be perceived as a swelling in the stolon plate.

Alaska colonies form thin mats moderately populated by scattered polyps or clusters of up to five polyps. Polyps appear to be mostly non-retractile and up to 6 mm in length. Mats up to 0.5 m^2 have been observed in situ that are contagiously distributed, giving the appearance of an infestation, and are strongly associated with red tree corals (*Primnoa pacifica*) with which they co-occur in shallow water of recently deglaciated fjords in Southeast Alaska (Stone and Mondragon, 2018).

Color in life is white to light pink; color in ethanol is light yellow to creamy white.

Remarks This species was originally described as *Evagora incrustans* by Broch (1935). *Sarcodictyon incrustans* is a pioneer species in recently deglaciated fjords of Glacier Bay National Park and Preserve in Southeast Alaska (Stone and Mondragon, 2018).

Distribution Uncommon. In Alaska – Muir and Johns Hopkins Inlets in Glacier Bay, Southeast Alaska (Fig. 14-2). Elsewhere – the type specimen was collected in the Sea of Okhotsk, Russia. A few specimens (USNM 57986 and 57987) were

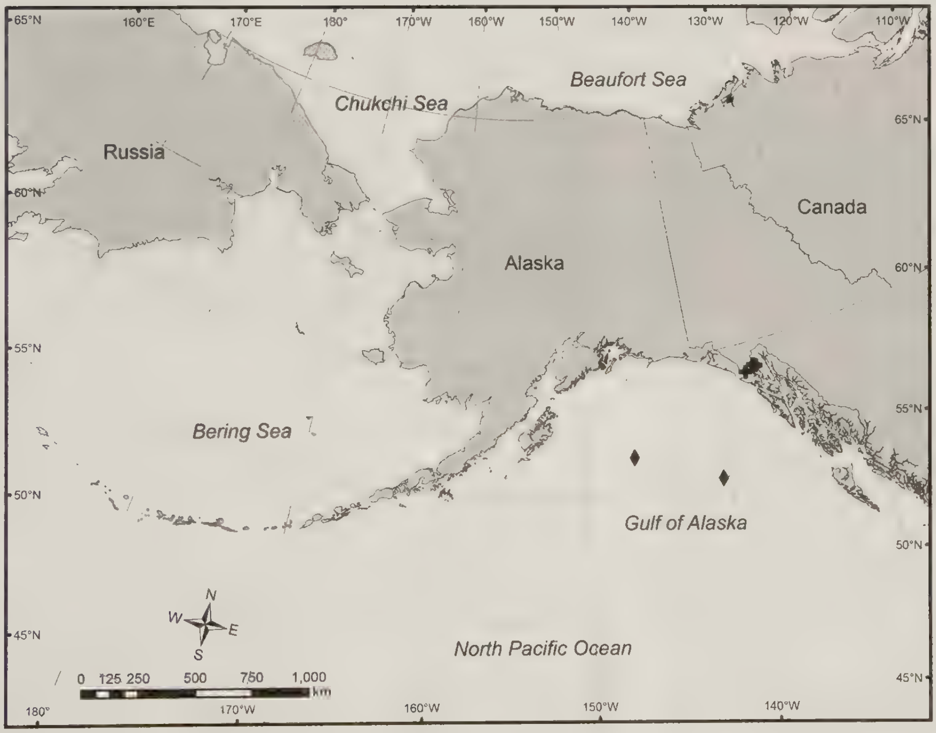


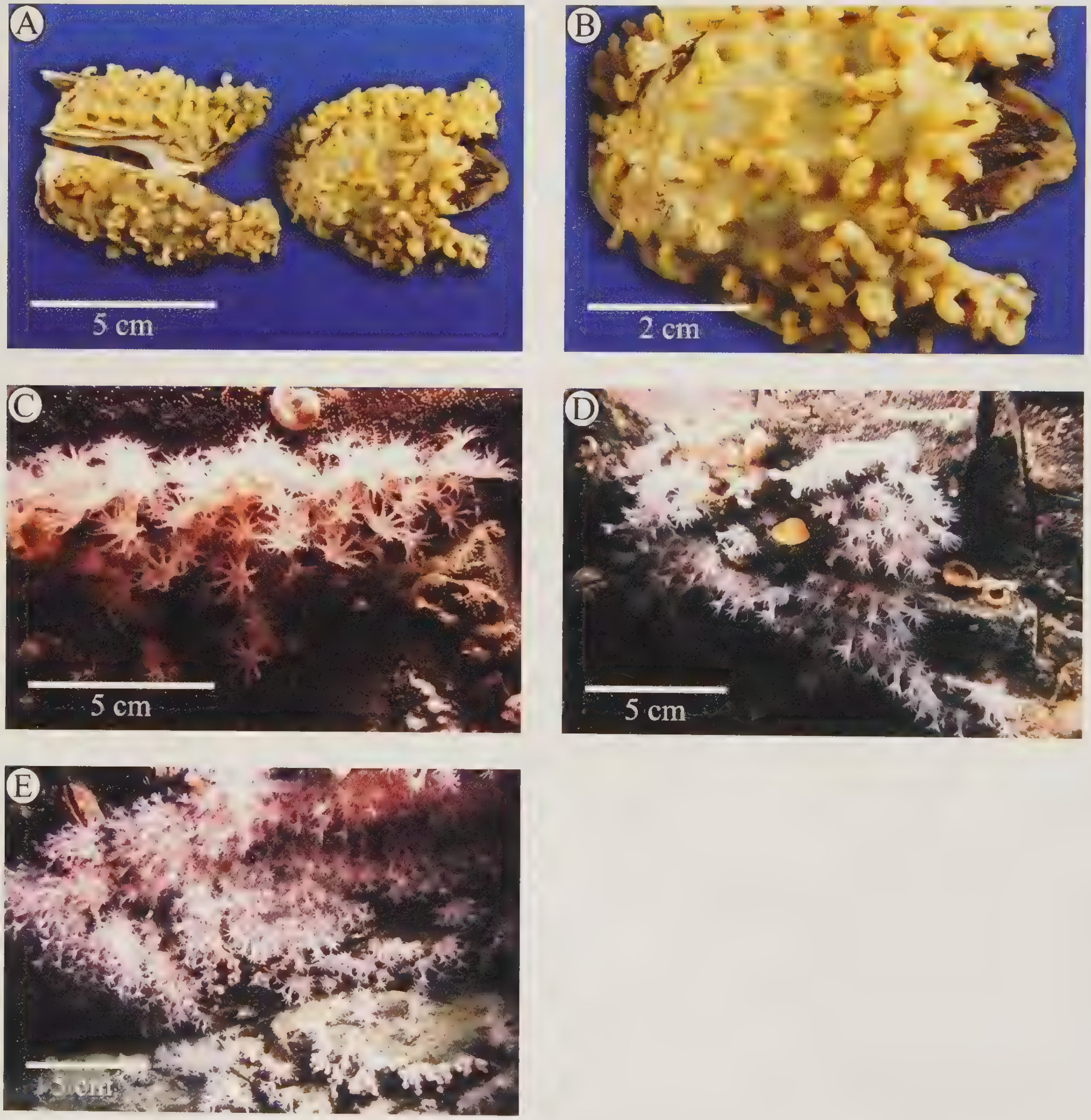
Figure 14-2

A map of the North Pacific Ocean showing the distribution of *Sarcodictyon incrustans* (+) and *Sarcodictyon* sp. A (♦) in Alaska waters.

collected in Barkley Sound, southwestern Vancouver Island, British Columbia, at a depth of 15 m and were identified as *Sarcodictyon* sp. but may likely be *S. incrustans*.

Habitat In Alaska – grows on hard rock, skeletons of both live and dead deepwater giant barnacles (*Chirona evermanni*) and brachiopods (*Laqueus californicus*), and the bare skeleton of red tree corals at depths between 15 and 238 m. Elsewhere – the type specimen was collected at a depth of 335 m.

Photos A) Preserved (in ethanol) whole *S. incrustans* colonies (USNM 1407056) collected in Muir Inlet, Glacier Bay, Southeast Alaska, at a depth of 21 m. The colonies are growing on deepwater giant barnacles. B) A close-up view of the specimen at right in photo A. C) *Sarcodictyon incrustans* colonies growing in Muir Inlet at a depth of 17 m. D) *Sarcodictyon incrustans* colonies growing in Muir Inlet at a depth of 24 m. E) *Sarcodictyon incrustans* colonies growing in Muir Inlet at a depth of 23 m. Note that some colonies have polyps that are in various stages of retraction.



2. *Sarcodictyon* sp. A

Description This species is known only from a single collected specimen that had completely overgrown the skeleton, including the holdfast of a hexactinellid sponge (*Crateromorpha* sp.). The sponge was attached to fractured bedrock and was a rare form in that the stalk was bifurcated approximately two-thirds from the base. The large distal caps of the sponge were missing at the time of collection, and the stolon had completely overgrown the tip of each stalk. The main stalk was 35 cm in length, the secondary stalk was 14 cm in length, and the mean circumference of the stalk was 5 cm. The entire colony had a surface area of 245 cm^2.

Calyces (polyps) are obviously conical and range up to 9 mm in diameter at the base and 6 mm in height, are relatively sparse, but are distributed throughout the entire colony in clusters of up to seven individuals. The coenenchyme is quite thin and the dark brown color of the underlying sponge is apparent. The color in life is a uniform peach-orange; the color in ethanol is yellowish-orange.

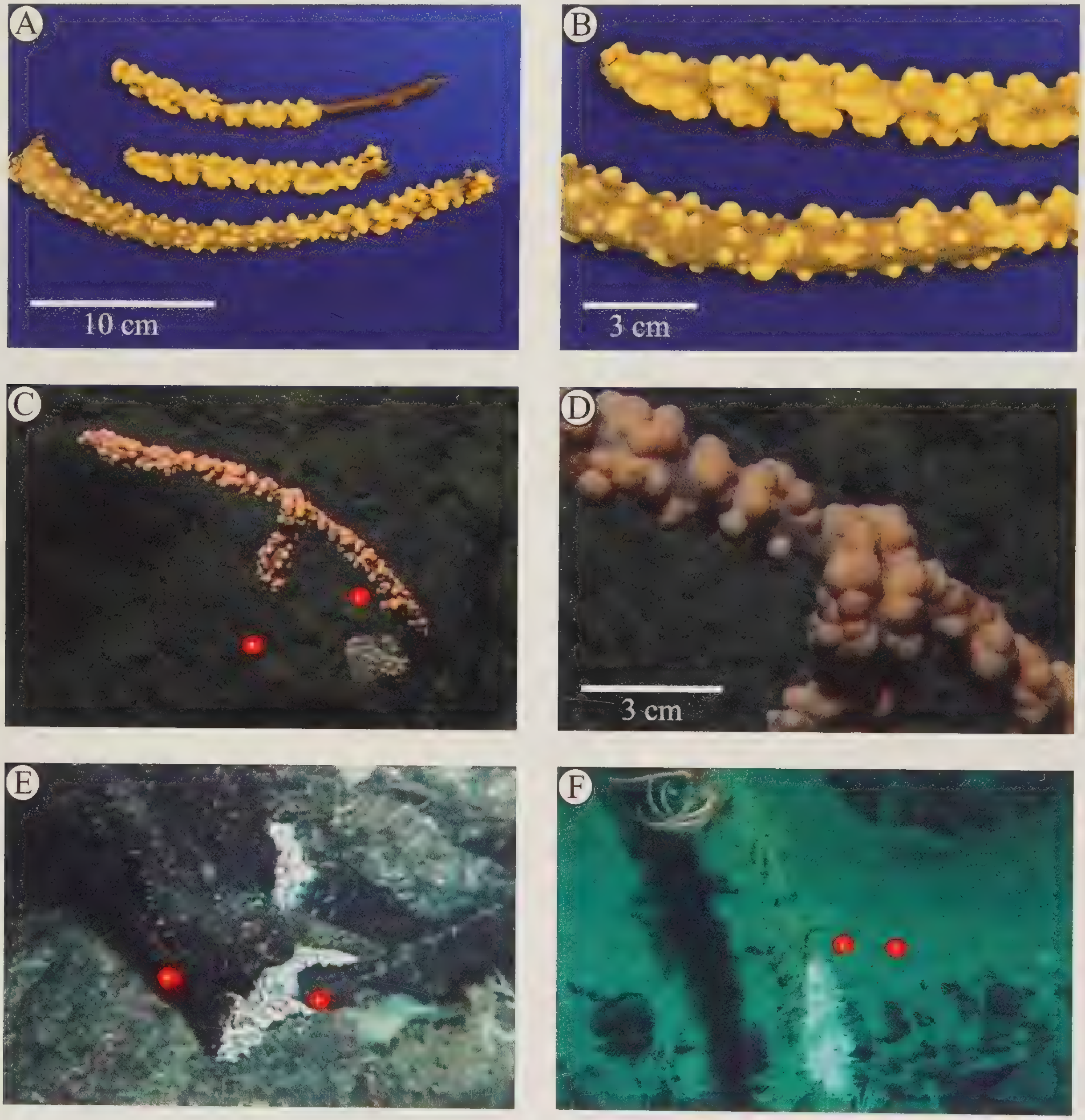
We made observations of an additional colony (not collected) growing on a *Crateromorpha* sp. skeleton on Welker Seamount and two colonies (not collected) growing approximately 3 cm apart on the side of a boulder on Welker Seamount at 2665 m depth. These latter two colonies were irregularly shaped, very thin encrustations with dimensions of 11×5 cm and 8×2 cm. The polyps were sparse and arranged mostly in rows that were oriented in various directions. The color of the live colonies was light orange.

Distribution Rare. In Alaska – known from a single collected specimen and video observations on Giacomini and Welker Seamounts in the Gulf of Alaska Seamount Province (Fig. 14-2). Elsewhere – unknown.

Habitat In Alaska – attaches to the bare skeleton of the hexactinellid sponge *Crateromorpha* sp. and on boulders at depths between 2665 and 2811 m.

Photos A) A preserved (in ethanol) whole *Sarcodictyon* sp. A colony (USNM 1076622), broken into three pieces when collected on Giacomini Seamount at a depth of 2811 m. B) A close-up view of the same specimen in photo A. C) The same colony in photo A with polyps fully retracted, photographed just prior to collection. D) A close-up view of the same colony in photo C with polyps fully retracted. E) Two *Sarcodictyon* sp. A colonies photographed on Welker Seamount at a depth of 2665 m. F) A *Sarcodictyon* sp. A colony with polyps extended, growing on the bare skeleton of the hexactinellid sponge, *Crateromorpha* sp., on Giacomini Seamount at a depth of 2808 m. The distance between the red laser marks in photos C, E, and F is 10 cm.

2. *Sarcodictyon* sp. A (continued)


A
10 cm
B
3 cm
C
D
3 cm
E
F

CHAPTER 15

Superfamily Pennatuloidea

Corals in the superfamily Pennatuloidea are known as sea pens and sometimes referred to as sea whips. Pennatuloideans that occur in Alaska waters are colonial, ahermatypic, gonochoric, and presumably broadcast spawners. As in other cnidarians, sea pens are modular organisms that can be viewed either as individuals with many standardized and repeating feeding structures, or as colonies composed of several to numerous individuals. We will use the latter term here.

Conventional terminology is used to describe sea pen morphology (Fig. 15-1). A sea pen colony is composed of a single large polyp called the oozooid that through lateral budding gives rise to secondary polyps, most notably large autozooids and siphonozooids. The autozooids are feeding polyps with eight well-developed feather-like tentacles (Fig. 15-1A), and the siphonozooids are smaller polyps with highly reduced or no tentacles and have a water circulation function (Fig. 15-1D). Together with two other kinds of polyps found in a few species of sea pens (mesozooids and acrozooids), pennatuloidean polyps are pentamorphic—that is, there are a total of five kinds of polyps found throughout the range of

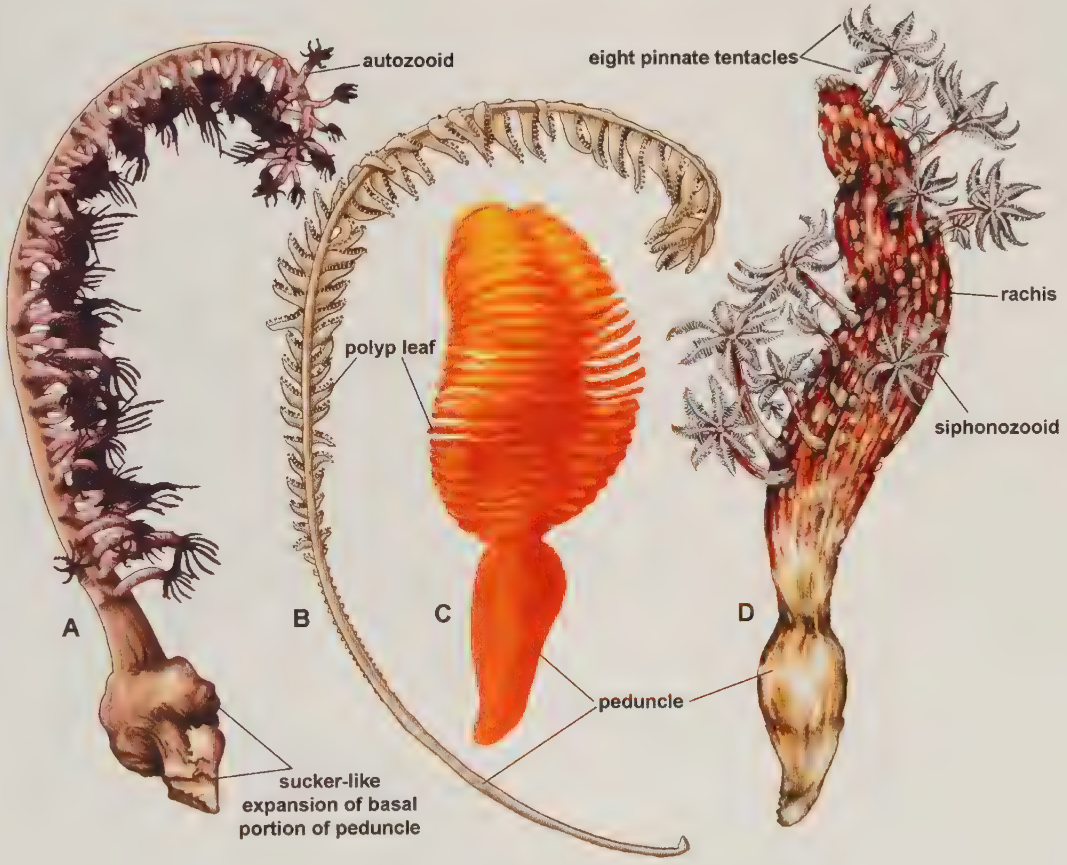


Figure 15-1

Illustrations of four species of coral in the superfamily Pennatuloidea showing distinct morphological features: (**A**) *Anthoptilum gowlettholmesae,* (**B**) *Acanthoptilim longifolium*, (**C**) *Ptilosarcus gurneyi*, and (**D**) *Veretillum manillense.* Illustrations were provided by Stephanie King (A and B), Laura Garrison (C), and Jessica Machnicki (D), California Academy of Sciences.

pennatuloidean diversity (Williams et al., 2012). The body of a sea pen colony is composed of the rachis (the distal portion of the colony that contains the polyps) and the peduncle (the muscular proximal portion that anchors the colony into soft benthic sediments) (Fig. 15-1, C and D).

In a few species known as rock-inhabiting sea pens, the end bulb or basal portion of the peduncle forms a plunger-like expansion (Fig. 15-1A) that is capable of adhering the colony to hard rocky substrate (Williams and Alderslade, 2011). Rock-inhabiting sea pens are known to inhabit a depth range of 368 to 1969 m (Williams[14]) and have only recently been discovered in Alaska waters. Two of the 14 sea pen families possess well-developed lateral extensions called polyp leaves emanating from the sides of the rachis that can each contain numerous autozooids, thus greatly increasing the number of feeding polyps on a single colony (Fig. 15-1, B and C).

Pennatuloideans in Alaska are not particularly speciose but appear to be relatively diverse with 9 of 14 families currently recognized worldwide (Williams, 1995) represented. We provisionally list 20 distinct taxa but caution that this group of corals is in desperate need of taxonomic study. The current state of taxonomy for the group is poor and there are several taxa with unresolved taxonomy (*Anthoptilum* spp., *Balticina* sp. A, *Kophobelemnon* sp., *Protoptilum* sp., *Virgularia* cf. *bromleyi*, and *Umbellula* sp.). Furthermore, there are several species with identifications based on only a few specimens, including *Anthoptilum murrayi* Kölliker, 1880; *Balticina californica* (Moroff, 1902); *Kophobelemnon* sp.; *Stachyptilum superbum* Studer, 1894; *Virgularia bromleyi* Kölliker, 1880; and *Virgularia* cf. *glacialis*. One taxon (*Pennatula* sp.) is known only from video records. All specimens collected in Alaska, except the obvious *Balticina willemoesi* (Kölliker, 1880) and *Ptilosarcus gurneyi* (Gray, 1860), should be properly preserved for taxonomic examination and zoogeographic study.

Pennatuloideans are found in all regions of Alaska except the Arctic; none are found further north than Navarin Canyon in the eastern Bering Sea (Fig. 15-2). The records for most taxa represent the northernmost in the world. They are common throughout the Gulf of Alaska and Bering Sea, less common in the Aleutian Islands, and rare in the Gulf of Alaska Seamount Province (Fig. 15-2) where they are known from only four

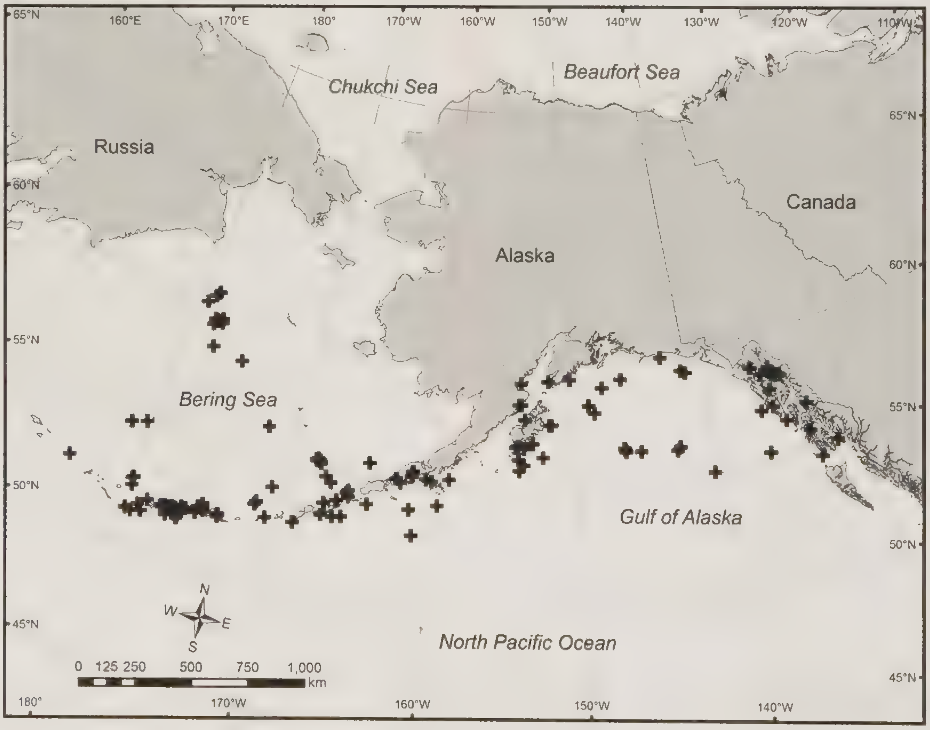


Figure 15-2

A map of the North Pacific Ocean showing the distribution of corals in the superfamily Pennatuloidea (+) in Alaska waters.

---

[14] Williams, G. C. 2019. The rockpens - sea pens that attach to rocky surfaces. Octocoral Research Center. Last revised September 2019. [Available from https://researcharchive.calacademy.org/research/izg/Rockpen%20Forest%20and%20Detail.html, accessed April 2021.]

species (*Anthoptilum murrayi*, *Anthoptilum* sp. A, *Anthoptilum* sp. B, and *Umbellula* sp.) on five seamounts (Welker, Pratt, Quinn, Giacomini, and Derickson Seamounts). They are extremely eurybathic fauna in Alaska occupying depths between 3 m (*Ptilosarcus gurneyi*) and 4656 m (*Umbellula* sp.).

In Alaska and worldwide, most pennatuloideans inhabit soft-sediment areas of low-relief seafloor with low to moderate water current. Colonies are anchored in place using a combination of hydrostatic pressure and peristalsis to bury the peduncle into the sediment (Williams, 1995). However, unlike most other corals, they are sessile rather than sedentary. Several species dislodged from the sediment, notably *B. willemoesi* and *Ptilosarcus gurneyi*, are able to rebury their peduncles and recover to an erect position (Malecha and Stone, 2009), and long-term observations of shallow-water populations indicate that individuals may move seasonally especially with regard to depth distribution (senior author, personal observ.).

Recently, a few species of pennatuloideans, known as rock-inhabiting sea pens, have been discovered that attach directly to hard substrate via a peduncle that is modified to function like a suction cup (Williams and Alderslade, 2011). The first rock-inhabiting sea pen from Alaska (*Anthoptilum* sp. A) is currently queued for formal description and a second one (*Anthoptilum* sp. B), observed on video footage only, is listed here to highlight it for future collection.

Many species are small, less than 50 cm in length and 5 cm in width, but a few attain lengths of 100 cm or more, and *B. willemoesi* attains lengths of 3 m—making it the largest sea pen in the world. Some species are locally abundant and are found in low- or high-density patches or "groves" and play a major role in constructing important benthic habitats in areas of otherwise featureless seafloor (Brodeur, 2001; Stone et al., 2005). The groves provide important refuge habitat for juvenile fish and crabs and intercept and concentrate passing detritus, offal, and dislodged macroalgae (Stone et al., 2005). Pennatuloideans appear to have few faunal associates compared to other octocorals, but often serve as elevated feeding platforms for numerous species of ophiuroids. Some nudibranch species from genera such as *Tritonia* and *Armina* are known to prey on pennatuloideans. Species within the current range of fishing activities in Alaska (approximately 1200 m depth), especially those not capable of retracting partially or wholly into the sediment (e.g., *Balticina* spp.), are particularly vulnerable to physical disturbance (Stone et al., 2005) and are common bycatch in trawl fisheries and stock assessment surveys (Heifetz, 2002).

Family Anthoptilidae

(Adapted from Nutting, 1909 and Williams, 1995) Corals in this family have elongate, whip-like colonies with free polyps and without bifurcated calyces. The rachis is without sclerites. The autozooids are disposed on raised ridges or pads that are obliquely arranged along the rachis. The proximal portions of adjacent autozooids are fused to some degree, forming small raised ridges, or joined only at the base. Polyp leaves are absent.

Species in the genus *Anthoptilum* have large autozooids that are numerous, elongate, and arranged biserially along either side of the rachis or in oblique rows situated in two series along the rachis. Zooids are present on all surfaces; sclerites are absent except in the interior of the stalk; and the anthocodiae are non-retractile. Adjacent autozooids may be united at their bases. Siphonozooids are minute but numerous on the rachis between the rows of autozooids.

1. *Anthoptilum grandiflorum* (Verrill, 1879)

Description Colonies are elongate and whip-like. Polyps are arranged in oblique rows and adjacent polyps are fused at the base. Alaska specimens typically display a strongly curved posture. The largest colonies are to about 50 cm in length. The colonies have a very large peduncle which appears as an exposed disk at the sediment surface and is capable of partial retraction into the sediment. The color is purple to crimson except the tissue along the axis and the peduncle is a paler orange or crimson.

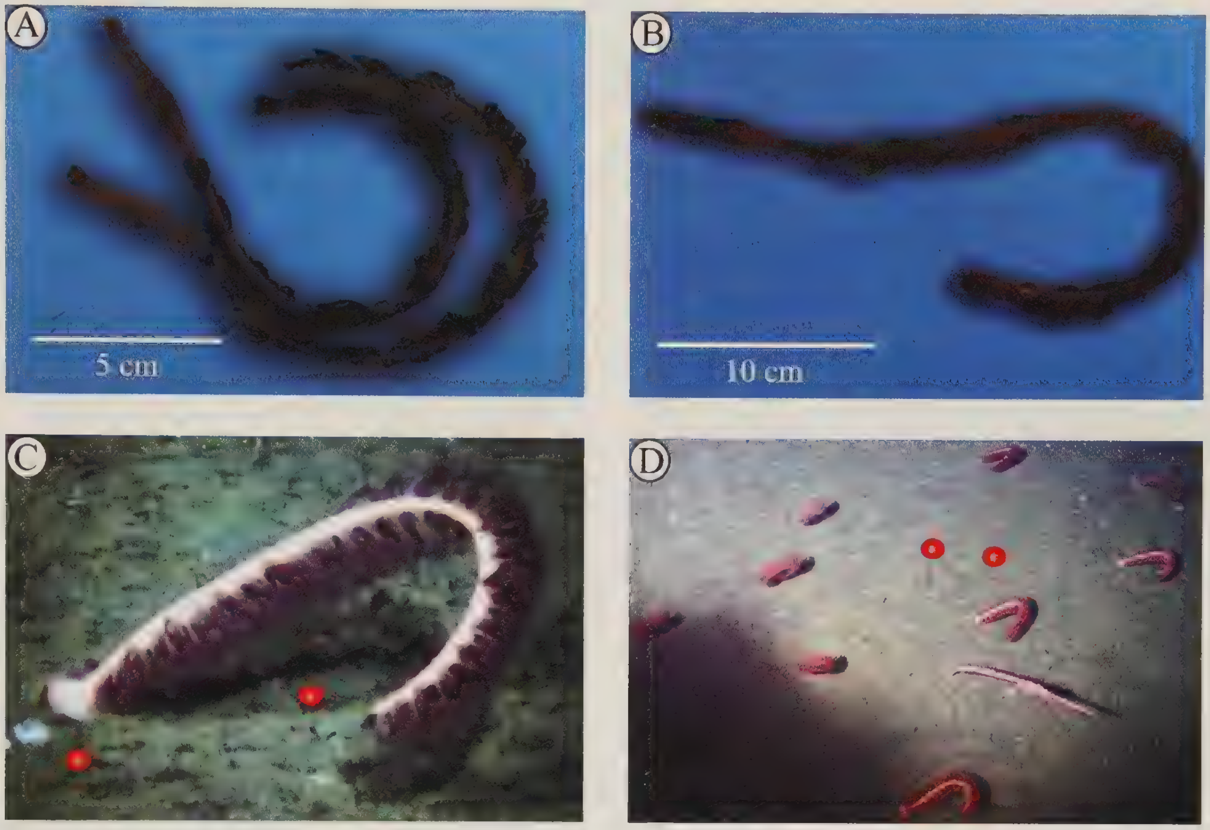
Remarks *Anthoptilum grandiflorum* occasionally serves as an elevated perch for the deep-sea ophiuroid *Asteronyx* sp., presumably to suspension feed (Fujita and Ohta, 1988).

The skeletal axis is composed of high-magnesium calcite (10.3 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon but locally abundant. In Alaska – eastern Gulf of Alaska, central Aleutian Islands including Bowers Bank that extends northward into the eastern Bering Sea, and the canyons of the eastern Bering Sea (Fig. 15-3). Elsewhere – cosmopolitan. North Pacific Ocean (off Washington, Oregon, California, and Hawaii), South Pacific Ocean (off Chile and Palau), the Straits of Magellan, Antarctica, South Atlantic Ocean (off the Falkland Islands), Gulf of Mexico, and the North Atlantic Ocean (off the east coast of North America).

Habitat In Alaska – typically found in groves, sometimes densely, rarely singly in soft sediment (silt and sand) at depths between 600 and 2146 m. Video observations indicate that the species ranges to depths of at least 2511 m in the central Aleutian Islands (Stone, 2014). Often found in mixed groves with the sea pen *Anthoptilum* sp. A and the chrysogorgiid *Radicipes stonei*. Elsewhere – eurybathic, found in soft-sediment areas at depths between 188 and 3651 m.

Photos A) Fresh whole *A. grandiflorum* colonies (CAS 222962) collected in Navarin Canyon in the eastern Bering Sea at a depth of 1116 m. B) A fresh whole *A. grandiflorum* colony (CAS 222949) collected north of Atka Island, central Aleutian Islands, at a depth of 2146 m. C) An *A. grandiflorum* colony photographed north of Atka Island at a depth of 2220 m. The distance between the red laser marks is 20 cm. D) A grove of *A. grandiflorum* colonies north of Atka Island at a depth of 2145 m. Also pictured is an *Anthoptilum* sp. A colony with an associated ophiuroid (*Asteronyx* sp.). The distance between the red laser marks is 40 cm.


A
5 cm
B
10 cm
C
D

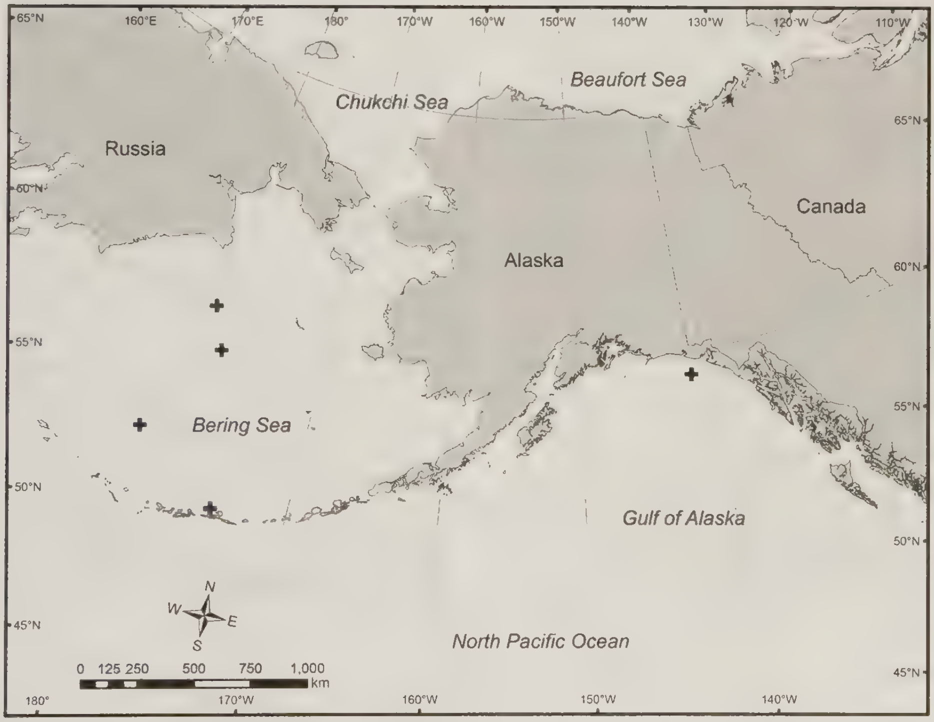

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
65°N
60°N
Canada
Alaska
60°N
55°N
Bering Sea
55°N
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 15-3

A map of the North Pacific Ocean showing the distribution of *Anthoptilum grandiflorum* (**+**) in Alaska waters.

2. *Anthoptilum murrayi* Kölliker, 1880

Description (Adapted from Kölliker, 1880) Colonies are elongate, whip-like, and appear to be quite flexible in situ (see photo E). Alaska specimens range to about 90 cm in length. One specimen collected on Giacomini Seamount in the Gulf of Alaska Seamount Province at a depth of 756 m (see photo B) has a total length of 48 cm divided over three regions as follows: 1) the peduncle is 33 mm in length and 6 mm in diameter (contracted), 2) the naked stalk is 57 mm in length and 4 mm in diameter, and 3) the polypoid section of the stalk is 39 cm in length with the diameter tapering to 2.7 mm. In larger specimens the tip of the rachis is flimsy and often tipped in situ, similar to that in *Balticina* sp. A. The rachis is sparsely populated with polyps arranged in oblique rows and adjacent polyps are separate and not fused at the base. Colonies are not able to retract any part of the rachis aside from the lower peduncle into the sediment. Color in situ is crimson to cranberry red, except the tissue along the axis is a paler crimson to orange. Specimens preserved in ethanol are pale orange, except in fresher specimens the polyps retain their natural color.

Remarks The specimen collected on Giacomini Seamount is the first specimen documented from a seamount anywhere for the species. The reproductive biology of this species has been studied from specimens collected off the coast of Brazil in the southwestern Atlantic Ocean (Pires et al., 2009). Atlantic Ocean specimens are known to host the large ophiuroid *Asteronyx* sp.

Distribution Rare (Fig. 15-4). In Alaska – known from only four specimens collected in the Aleutian Islands and on Giacomini Seamount in the Gulf of Alaska Seamount Province. The Aleutian Island specimens (USNM 16843) were collected north of Amukta Pass in the eastern Aleutian Islands at a depth of about 2266 m by the U.S. Fisheries Steamer *Albatross* and identified by C. C. Nutting.

The third specimen (CAS 9459) was collected during the same expedition on Bowers Bank further west at a depth of 1068 m. The identifier of that specimen is unknown. Eight additional specimens were observed in situ on Giacomini Seamount. Elsewhere – there are purported records in the North Pacific Ocean from Hawaii, off California, and near Honshu, Japan, but this is principally a North Atlantic Ocean species where it is common along the east coast of the United States, the Bahamas, Caribbean Sea, and off the west coast of Africa.

Habitat In Alaska – occurs singly or in low-density patches in low-relief, soft sediment (sand, silt, and green mud) habitat with light currents at depths between 1068 and 2266 m (Aleutian Islands). Seamount specimens occur on moderate slopes of sand, pebbles, and scattered cobbles and at depths between 744 and 762 m. Elsewhere – offshore banks and canyons at depths between 558 and 2491 m.

Photos A) Preserved (in ethanol) whole *Anthoptilum murrayi* colonies (USNM 16843) collected north of Amukta Pass, eastern Aleutian Islands, at a depth of

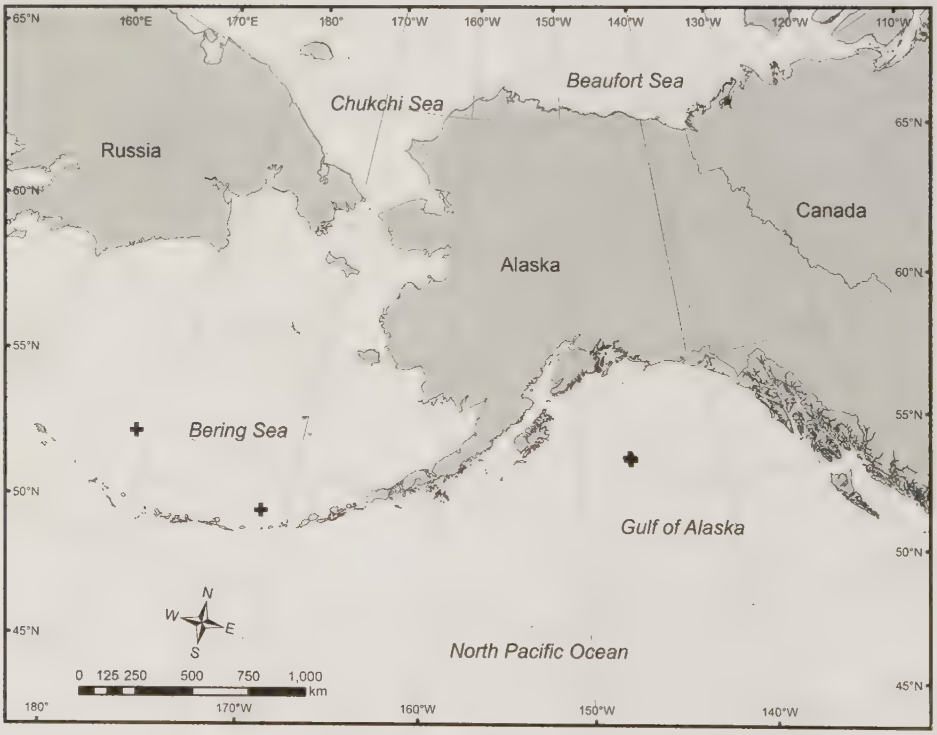
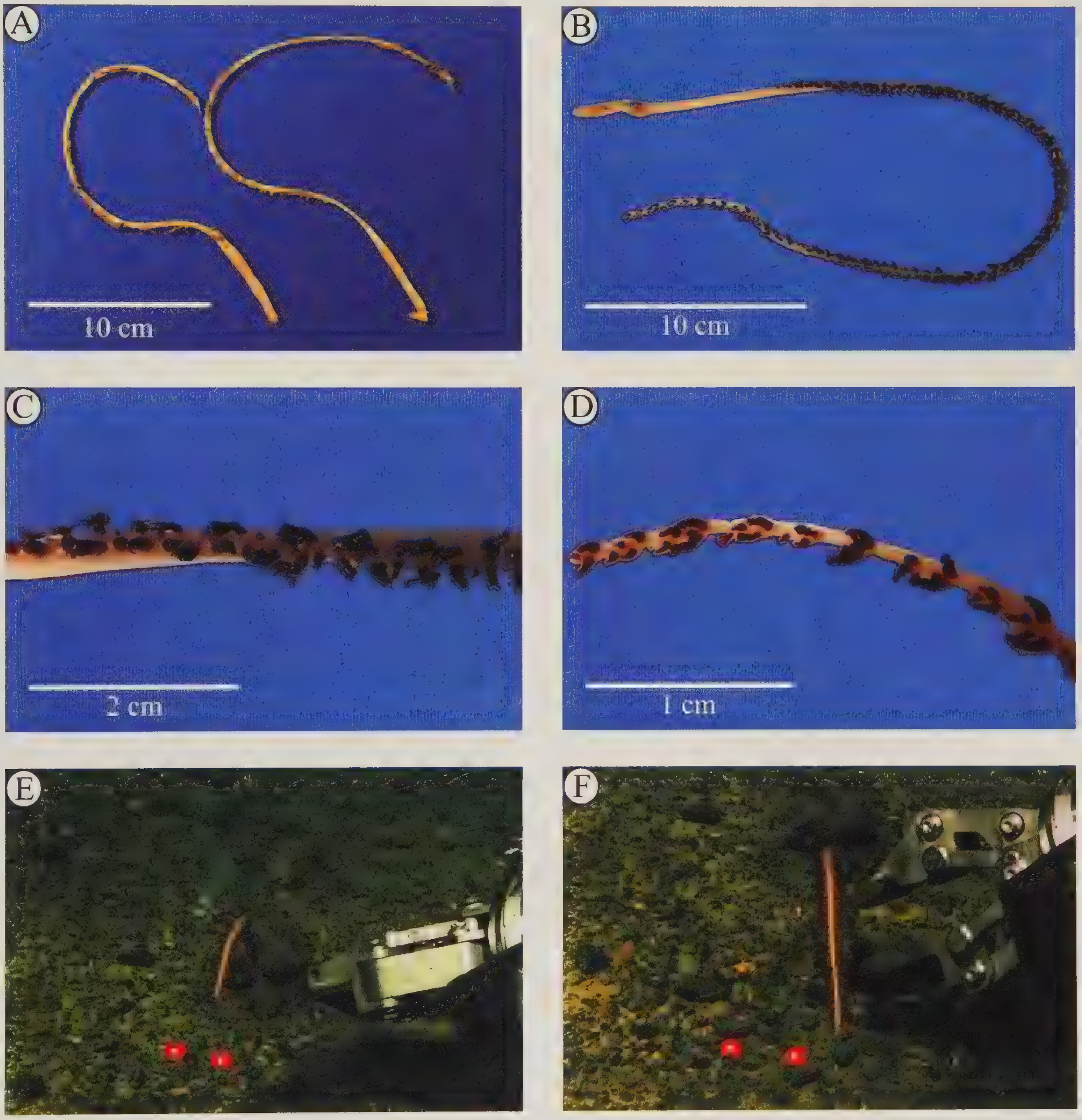


Figure 15-4

A map of the North Pacific Ocean showing the distribution of *Anthoptilum murrayi* (+) in Alaska waters.

2266 m. B) A preserved (in ethanol) whole *A. murrayi* colony (CAS 233658) collected on Giacomini Seamount at a depth of 756 m. C) A close-up view of the same specimen in photo B showing the detail and arrangement of the polyps on the central region of the rachis. D) A close-up view of the same specimen in photo B showing the detail and arrangement of the polyps on the tip of the rachis. E) The same colony in photo B prior to collection showing the flexibility of the rachis. F) The opposite view of the same colony in photo B prior to collection. The distance between the red laser marks in photos E and F is 10 cm.



3. *Anthoptilum* sp. A

Description Colonies are elongate and have a bushy appearance in situ. They have a slight bend but are quite flexible and not rigid. The symmetry of the colony is not bilateral but rather trilateral or circular. The largest colony (USNM 1075802) measures 9.5 cm in height and 7.6 cm in width (with the polyps fully extended). The peduncle is short (< 1 cm) in preserved specimens but considerably larger in situ when expanded. The peduncle terminus is modified into a large (25 mm diameter) suction cup for attachment to rock and is light orange in color. The rachis consists of a short naked stalk (only 8% of the total length); the remaining rachis is sparsely populated with up to 28 large polyps (autozooids) that originate directly from the rachis. The polyp stalk is long and tubular (up to 2.8 cm in length and 0.5 cm in width); the tentacles are up to 15 mm in length.

Compared to *Anthoptilum* sp. B, this species has far fewer polyps that appear to be more circularly arranged than in a single plane. Polyp color in life is crimson and the coenenchyme elsewhere is a paler crimson to light orange (almost translucent). The color in ethanol is brownish purple and the peduncle and axis are pale orange.

Remarks The two collected specimens represent a new species of rock-inhabiting sea pen, a recently discovered and unique group of pennatuloideans that attach directly to rock rather than bury in soft sediment. This new species is currently queued for formal description. It is morphologically similar to *A. lithophilum* Williams and Alderslade, 2011 known from off California including Rodriguez Seamount at depths of 669 to 700 m.

Distribution Rare. In Alaska – known from only two specimens (USNM 1075802 and CAS 233656) collected on Pratt and Quinn Seamounts in the Gulf of Alaska Seamount Province but observed on video footage elsewhere on Pratt Seamount and on nearby Giacomini Seamount (Fig. 15-5). Occurs singly, rarely two together. Elsewhere – unknown.

Habitat Attaches to fractured bedrock and cobbles in moderate- to high-relief habitat with moderate currents, at depths between 898 and 1095 m.

Photos A) A fresh whole *Anthoptilum* sp. A colony

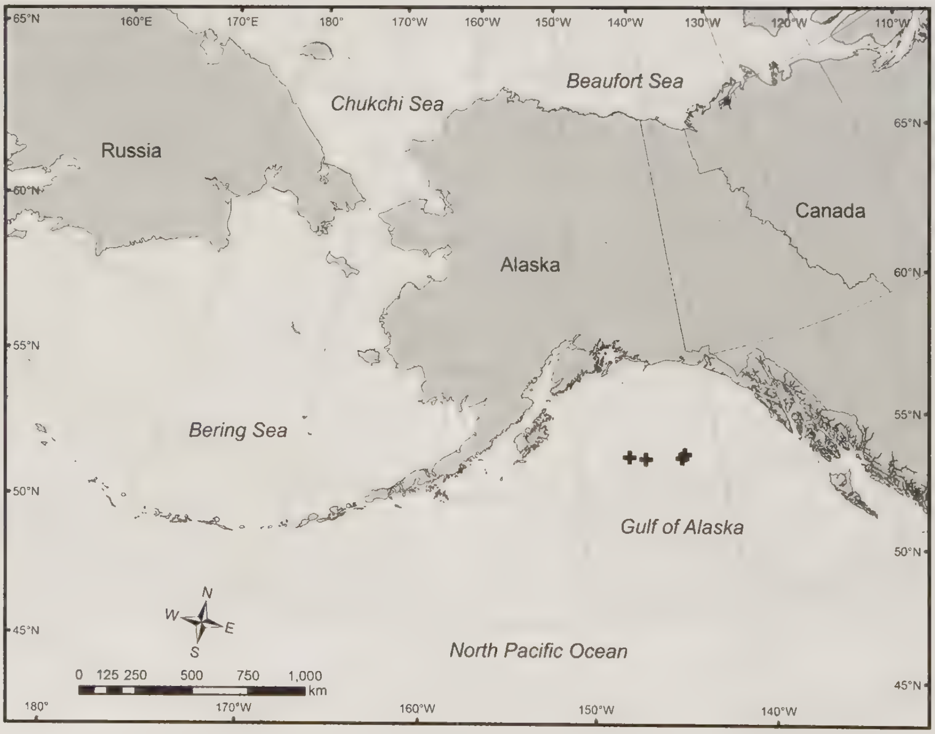
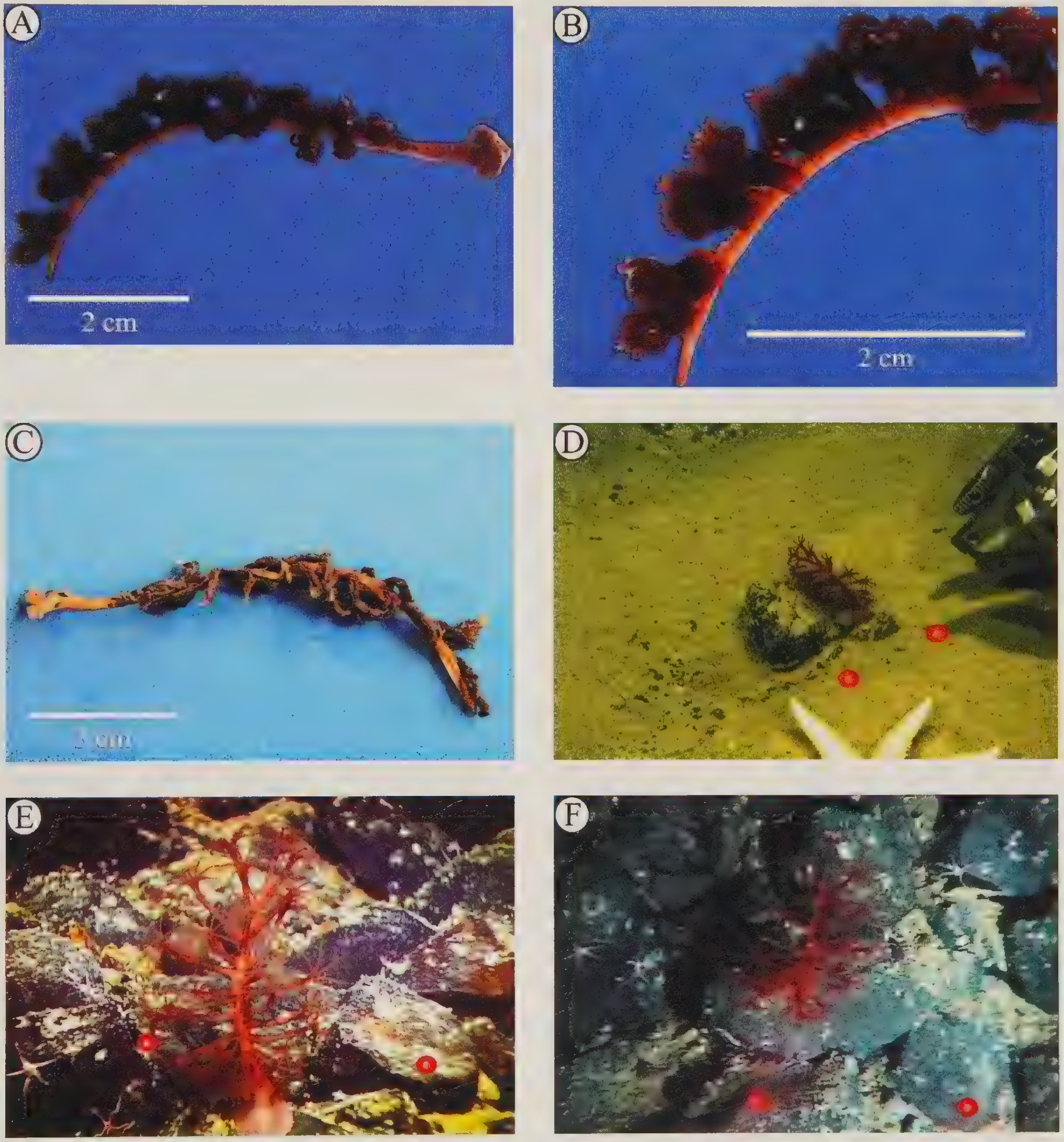


Figure 15-5

A map of the North Pacific Ocean showing the distribution of *Anthoptilum* sp. A (**+**) in Alaska waters.

(CAS 233656) collected on Quinn Seamount at a depth of 898 m. B) A close-up view of the same specimen in photo A. C) A preserved (in ethanol) whole *Anthoptilum* sp. A colony (USNM 1075802) collected on Pratt Seamount at a depth of 1095 m. D) An *Anthoptilum* sp. A colony (CAS 233656) prior to collection. E) A lateral view of an *Anthoptilum* sp. A colony (USNM 1075802) prior to collection. F) The view from atop the same colony in photo E. The distance between the red laser marks in photos D–F is 10 cm.



4. *Anthoptilum* sp. B

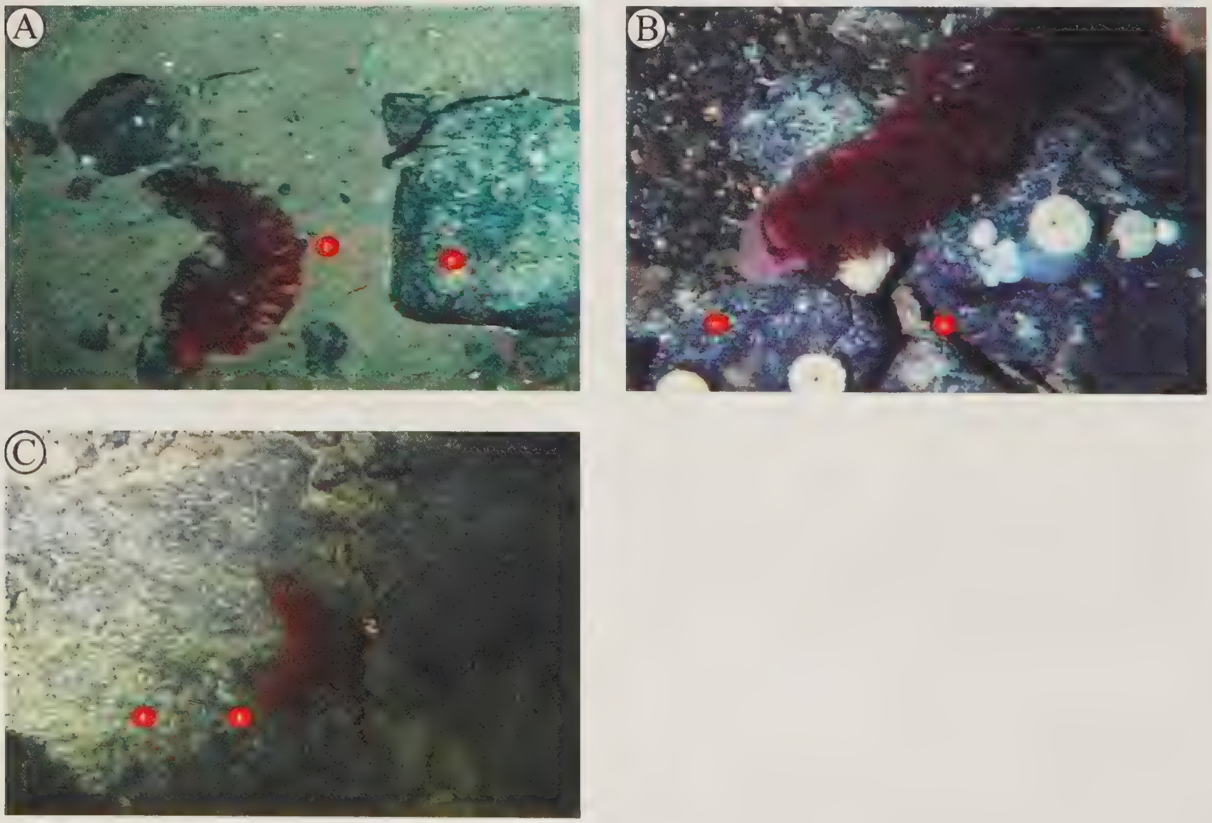
Description Colonies are elongate and whip-like but with a bushy appearance in situ. They characteristically have a slight bend. The largest colonies measure to about 22 cm in height and about 9 cm in width (with the polyps fully extended). The polyps start directly above the naked, cup-shaped peduncle and there are approximately 20 polyp pairs opposite of each side of the axis with the length of the polyps decreasing distally. Very large polyps (the tubular polyp stalk is up to 3.8 cm in length) originate directly from the rachis. The color in life is crimson; the peduncle is a paler crimson; and the axis is light orange.

Remarks This taxon also represents a new species of rock-inhabiting sea pen. The species is known from 53 observations made from video footage of the seafloor on Welker, Pratt, and Giacomini Seamounts in the Gulf of Alaska Seamount Province. The species cannot be formally described until a specimen is collected but until that time we list it here with an informal description. It is clearly different from *Anthoptilum* sp. A and not similar to any congeners in the northern North Pacific Ocean. It appears to be more common than *Anthoptilum* sp. A and while the two species are found on the same seamounts, they are not found in close proximity to each other.

Distribution Uncommon. In Alaska – observed on three seamounts (Welker, Pratt, and Giacomini) in the Gulf of Alaska Seamount Province (Fig. 15-6). Mostly occurs singly but occasionally two or three together. Elsewhere – unknown.

Habitat Attaches to bedrock, fractured bedrock, boulders, and cobbles in moderate-relief, moderate-current habitat, at depths between 797 and 1784 m (Welker Seamount, 797–1126 m; Pratt Seamount, 917–1193 m; Giacomini Seamount, 819–1784 m).

Photos A) An *Anthoptilum* sp. B colony observed on Pratt Seamount at a depth of 1053 m. B) An *Anthoptilum* sp. B colony observed on Giacomini Seamount at a depth of 991 m. C) An *Anthoptilum* sp. B colony observed on Welker Seamount at a depth of 1032 m. The distance between the red laser marks in photos A–C is 10 cm.



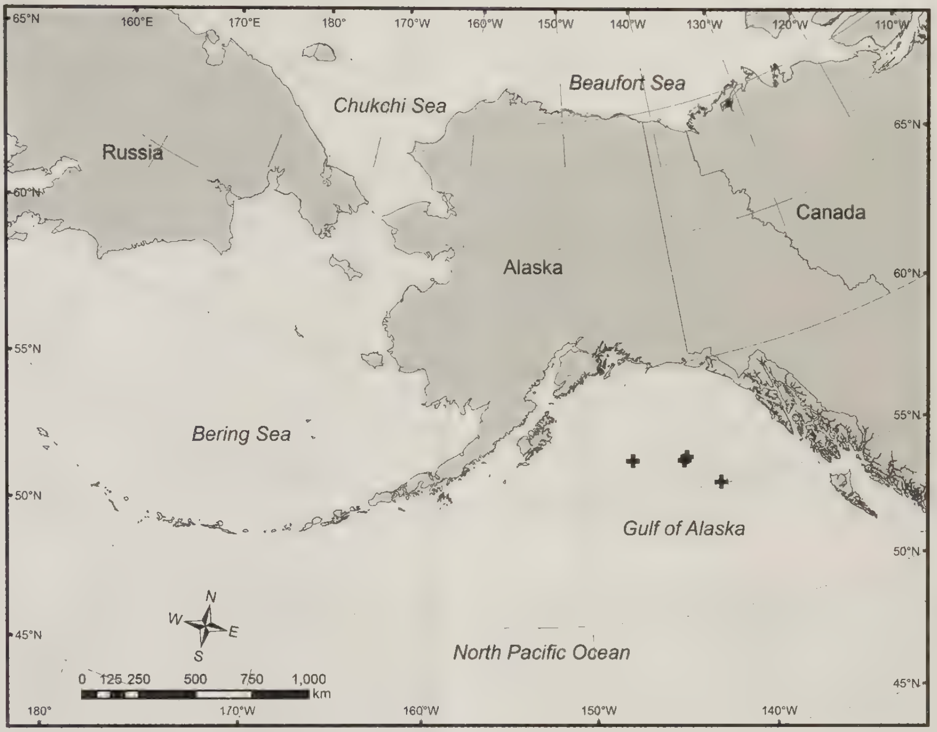

Russia
Chukchi Sea
Beaufort Sea
Alaska
Canada
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000
km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 15-6

A map of the North Pacific Ocean showing the distribution of *Anthoptilum* sp. B (+) in Alaska waters.

5. *Anthoptilum* sp. C

Description Colonies are elongate, whip-like, and very slender. The largest colonies measure to at least 95 cm in height and to only 1.5 cm in width. The lower 20–27% of the rachis is without autozooids. The peduncle is moderately enlarged (approximately twice the width of the lower rachis), is typically 13–17% of the total colony length, and rarely has a slight bend at the base. The autozooids are arranged in two discrete rows on the same side of the rachis and appear to be nearly opposite but may be randomly arranged. The peduncle is the only part of the colony that is retractable into the sediment. Colonies bend in the current, particularly at the tip where there is little and often no flesh. The color of the polyps is dark purple to crimson, lighter orange along the axis, and the peduncle is a slightly darker orange.

The taxonomy of this species is unresolved so specimens should be carefully re-examined. It may be the same species as *Anthoptilum* sp. D but here we list them separately due to the apparent difference in zoogeography, depth distribution, habitat, and gross morphology.

Remarks The species often serves as an elevated perch for the deep-sea ophiuroid *Asteronyx* sp., presumably to suspension feed (Fujita and Ohta, 1988). *Anthoptilum* sp. C is preyed upon by an unknown sea star, apparently a species of *Solaster* (Stone, 2014). The skeletal axis is composed principally of high-magnesium calcite (10.4 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon but locally abundant. In Alaska – north of Atka Island to Amchitka Pass in the central Aleutian Islands (Fig. 15-7). Elsewhere – unknown.

Habitat In Alaska – typically found in groves, rarely singly in soft sediment (silt and sand), at depths between 1667 and 2707 m (Stone, 2014).

Photos A) Fresh whole *Anthoptilum* sp. C colonies (CAS 222973) collected northwest of Tanaga Island, central Aleutian Islands, at a depth of 2308 m. B) A grove of *Anthoptilum* sp. C and associated ophiuroids (*Asteronyx* sp.) northwest of Tanaga Island at a depth

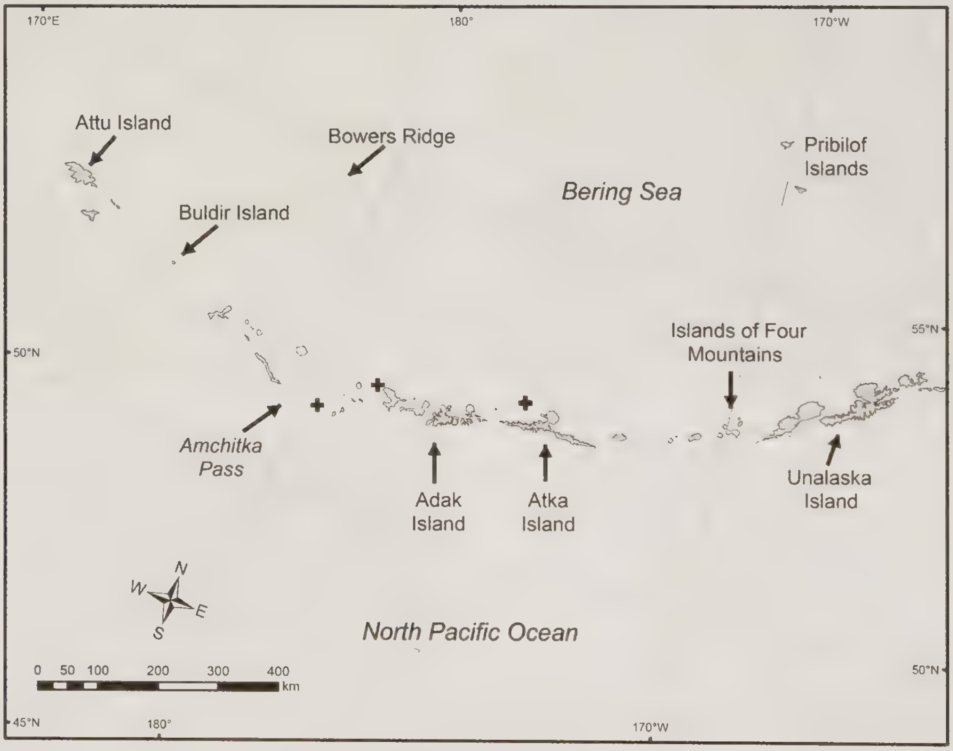
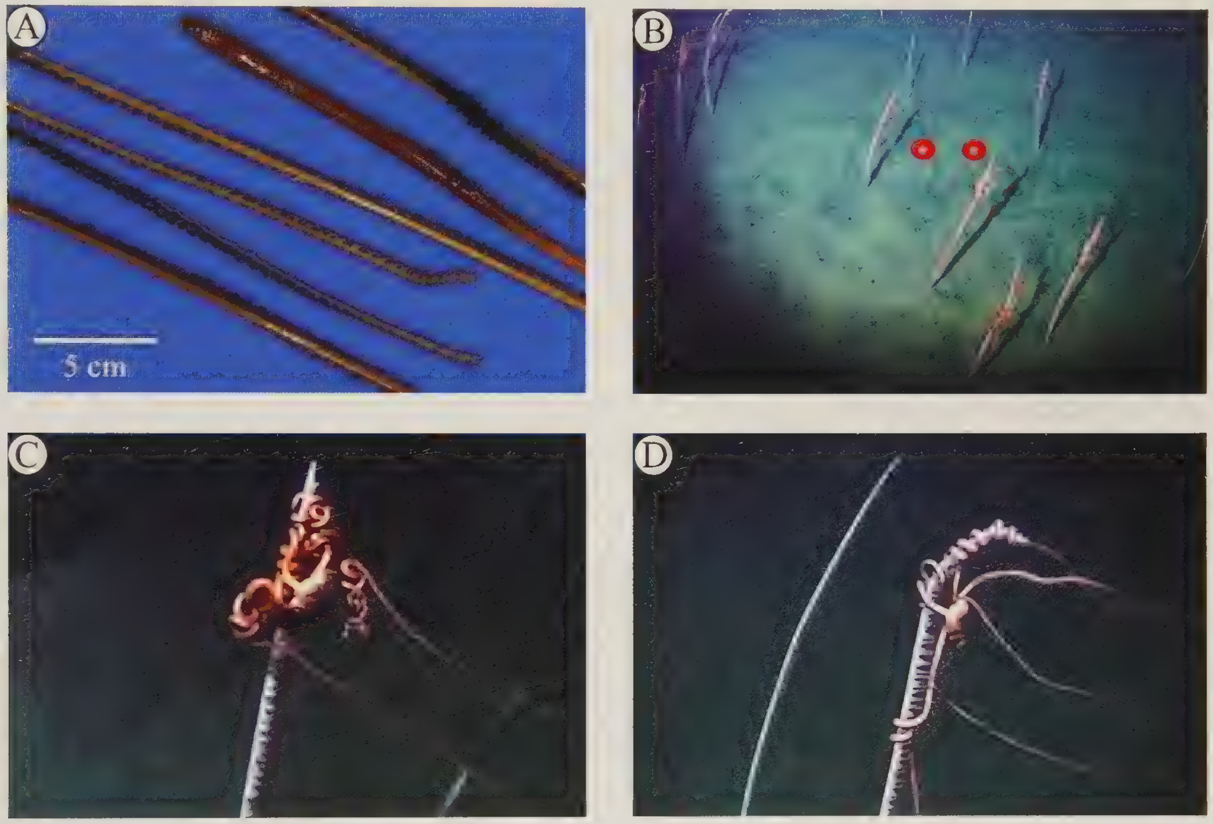


Figure 15-7

A map of the Aleutian Islands showing the distribution of *Anthoptilum* sp. C (**+**) in Alaska waters.

of 2250 m. The distance between the red laser marks is 30 cm. C) A close-up view of an *Anthoptilum* sp. C colony (J2096-2-1; CAS # pending) with associated ophiuroid (*Asteronyx* sp.) in a grove north of Atka Island at a depth of 2329 m. D) A close-up view of an *Anthoptilum* sp. C colony tip and associated ophiuroid (*Asteronyx* sp.) in a grove northwest of Tanaga Island at a depth of 2308 m.



6. *Anthoptilum* sp. D

Description Colonies are elongate, whip-like, and very slender. The largest colonies are up to at least 66 cm in height but only 1 cm in width. The lower 26–32% of the rachis is without autozooids. The peduncle is moderately enlarged (approximately twice the width of the lower rachis), is typically 11–17% of the total colony length, and often has a slight bend near the base. The autozooids are arranged somewhat haphazardly in two rows on the same side of the rachis and appear to be nearly opposite but may be randomly arranged. The peduncle is the only part of the colony that is retractable into the sediment. The color of the polyps is dark purple to crimson, lighter orange along the axis, and the peduncle is a slightly darker orange.

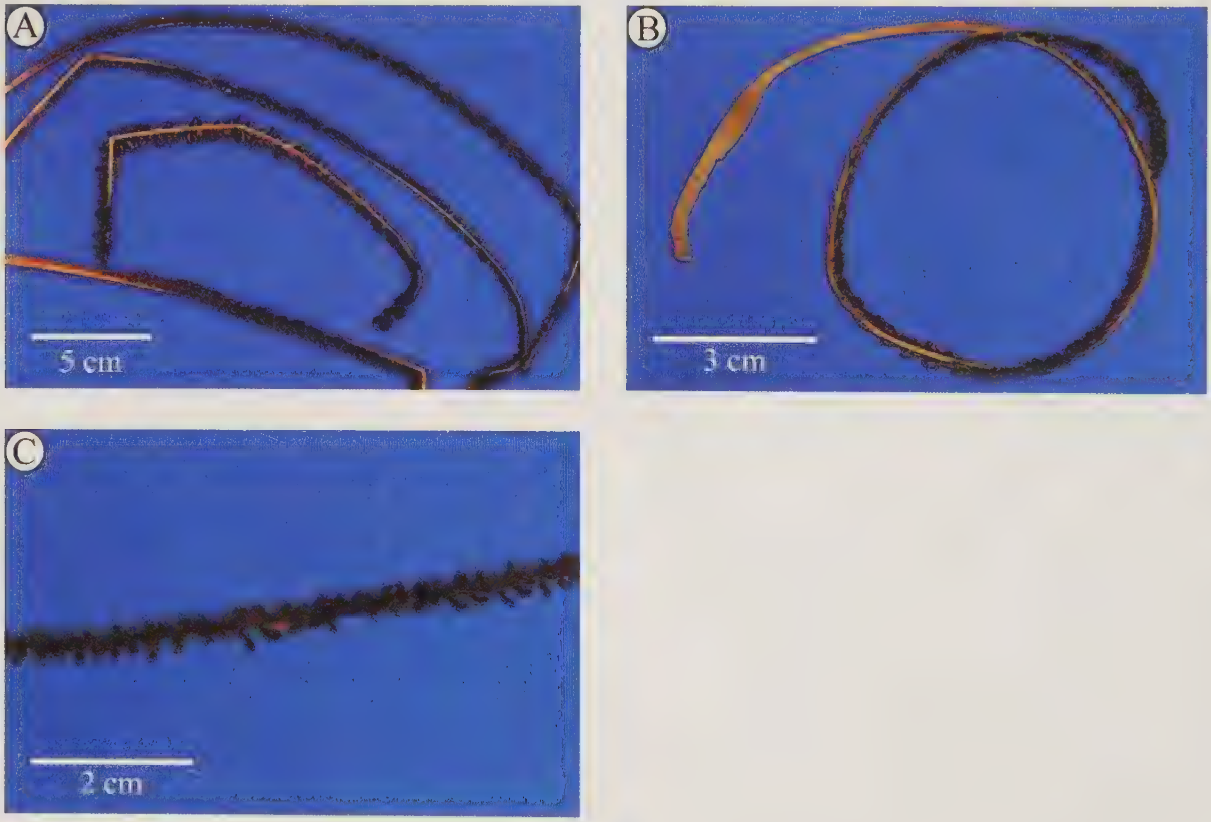
The taxonomy of this species is unresolved so specimens should be carefully re-examined. It may be the same species as *Anthoptilum* sp. C but here we list them separately due to the apparent difference in zoogeography, depth distribution, habitat, and gross morphology.

Remarks The species often serves as an elevated perch for the deep-sea ophiuroid *Asteronyx* sp., presumably to suspension feed (Fujita and Ohta, 1988).

Distribution Uncommon but locally abundant. In Alaska – the continental slope of the eastern Bering Sea including the large submarine canyons that incise the slope (Fig. 15-8). Elsewhere – unknown.

Habitat In Alaska – typically found in groves, rarely singly in soft sediment (silt and sand), at depths between 230 and 1116 m.

Photos A) Fresh whole *Anthoptilum* sp. D colonies (CAS 222961) collected in Navarin Canyon, eastern Bering Sea, at a depth of 1116 m. B) A fresh whole *Anthoptilum* sp. D colony (CAS 223765) collected south of Pribilof Canyon, eastern Bering Sea, at a depth of 244 m. C) A close-up view of a fresh *Anthoptilum* sp. D specimen (CAS 223756) collected south of Pervenets Canyon, eastern Bering Sea, at a depth of 465 m.



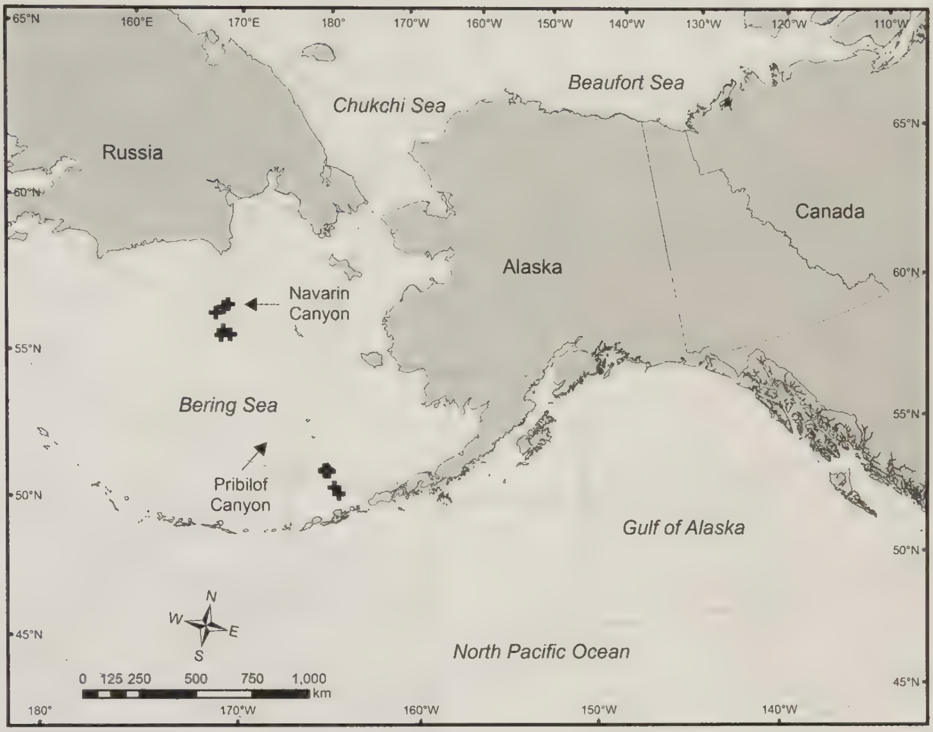

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
60°N
65°N
Canada
Alaska
60°N
Navarin
Canyon
55°N
Bering Sea
55°N
Pribilof
Canyon
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 15-8

A map of the North Pacific Ocean showing the distribution of *Anthoptilum* sp. D (+) in Alaska waters.

Family Balticinidae

(Adapted from Nutting, 1909 and Williams, 1995) Corals in this family have elongate, whip-like colonies with polyps that are retractile into calyces bearing two teeth. The rachis is bilateral throughout. The autozooids are lateral only and disposed on raised ridges or pads that are obliquely arranged along the rachis. The proximal portions of adjacent autozooids are fused to some degree, forming polyp leaves or raised ridges, or joined only at the base. Spiculated calyces are present and are bifurcated. Siphonozooids are sparsely scattered on the rachis between the oblique rows of autozooids. Species in this family differ from those in the family Anthoptilidae by having a rachis with sclerites, polyps with bifurcated calyces as opposed to none, and the presence of polyp leaves.

After a very recent and extensive literature review of this group of sea pens, they were placed in the family Balticinidae (= Halipteridae) and the genus *Balticina* (= *Halipteris*) by Pérez et al. (2021).

7. *Balticina californica* (Moroff, 1902)

Description (Adapted from Kükenthal, 1915b) Colonies are elongate and whip-like; the largest colonies measure up to 82 cm in height and up to 2 cm in width. The lower third of the colony is typically without polyps. There are less than five polyps per row on each polyp leaf compared to more than five polyps per row in *Balticina willemoesi*. The lower peduncle is the only part of the colony that is retractable into the sediment. The color of the polyps is orange to light orange with purple/crimson highlights; the coenenchyme along the rachis is a lighter orange. All colors fade when the colony is preserved in ethanol.

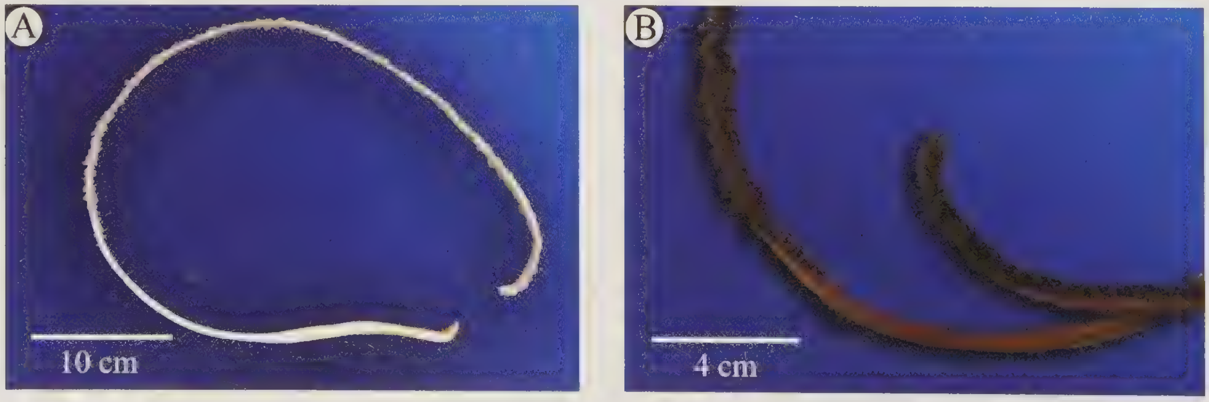
The taxonomy of this species is unresolved so specimens should be carefully re-examined. It is represented in Alaska waters by only five specimens that may be the same species as *Balticina* sp. A. We list them separately until the specimens have been expertly re-examined.

Remarks This species often serves as an elevated feeding platform for the common basket star (*Gorgonocephalus eucnemis*) in shallower water.

Distribution Uncommon. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, central and western Gulf of Alaska, and the eastern Aleutian Islands (Fig. 15-9). Elsewhere – found south along the west coast of North America to northern California.

Habitat In Alaska – typically found singly but occasionally in small patches or groves of up to 10–20 colonies in soft sediment (sand and silt) at depths between 35 and 823 m. Elsewhere – found in soft-sediment areas at depths between 60 and 2189 m.

Photos A) A preserved (in ethanol) whole *B. californica* colony (USNM 1212106) collected in Monterey Bay, northern California, at a depth of 1567 m. B) A close-up view of the lower rachis and tip of a preserved (in ethanol) *B. californica* specimen (USNM 1206259) collected in Monterey Bay at a depth of 60 m.



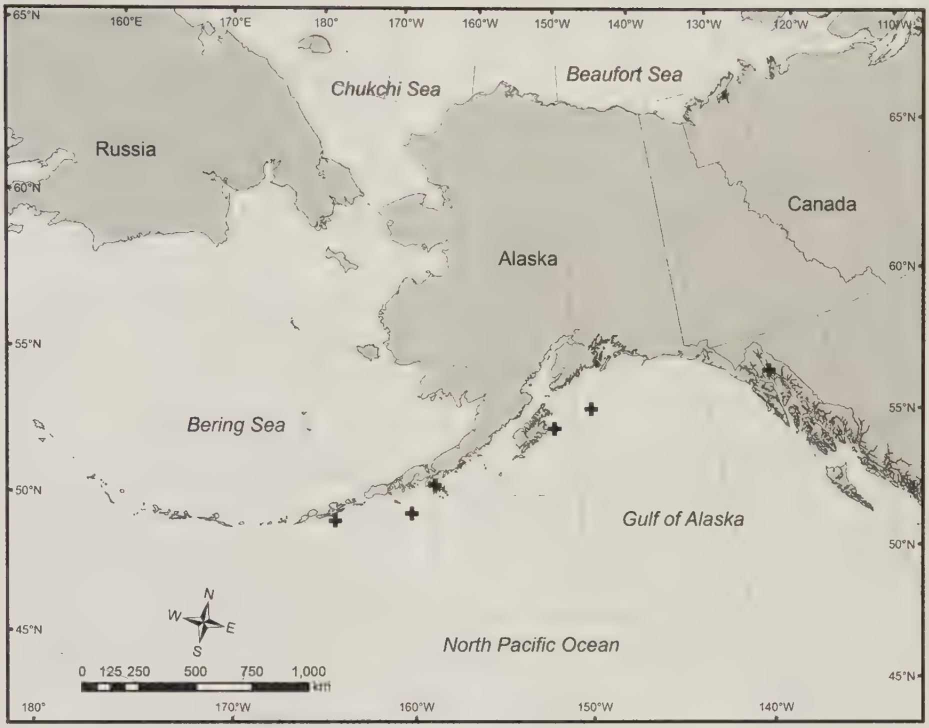

Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000
km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 15-9

A map of the North Pacific Ocean showing the distribution of *Balticina californica* (+) in Alaska waters.

8. *Balticina willemoesi* (Kölliker, 1880)

Description (Adapted from Kükenthal, 1915b) Colonies are elongate and whip-like; the largest colonies typically measure up to 150 cm in height but up to 3 m in exceptional specimens (north of Amlia Island, central Aleutian Islands) and up to 3 cm in width. There are more than five polyps per row on each polyp leaf compared to less than five polyps per row in *Balticina californica*. The lower peduncle is the only part of the colony that is retractable into the sediment. The color of the flesh is orange to light pink and lighter along the axis. All colors fade when the colony is preserved in ethanol.

Remarks The skeletal axis is composed principally of high-magnesium calcite (9.8 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data). The age and axial growth rates have been estimated for this species in the Bering Sea and range up to 44 years and 3.6–6.1 cm/year depending on age (Wilson et al., 2002). This species is preyed upon by the nudibranch *Tritonia diomedea* (Malecha and Stone, 2009), and colonies are capable of producing a bluish-green luminescence when physically disturbed in situ.

Distribution Common, widespread and locally abundant. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, the central and western Gulf of Alaska, the Aleutian Islands west to at least Adak Island, and the eastern Bering Sea continental slope including the canyons (Fig. 15-10). Absent from the seamounts in the Gulf of Alaska Seamount Province likely because all summits are deeper than the range of this species. Elsewhere – found south along the west coast of North America to southwest of the Columbia River Basin, Oregon; west to the Sea of Okhotsk, Russia; and the east side of Hokkaido, Japan. Five specimens collected by the U.S. Fisheries Steamer *Albatross* in 1906 from the East China Sea (west of the Osumi Islands, Japan) at a depth of 660 m were identified by G. Williams as *B.* cf. *willemoesi*.

Habitat In Alaska – typically found in groves, sometimes quite dense, rarely singly, in soft sediment (sand and silt) at depths between 18 and 310 m. Elsewhere – found in soft-sediment areas at depths between 69 m in the Sea of Okhotsk and 1204 m off Washington. This species has been observed in dense groves as shallow as

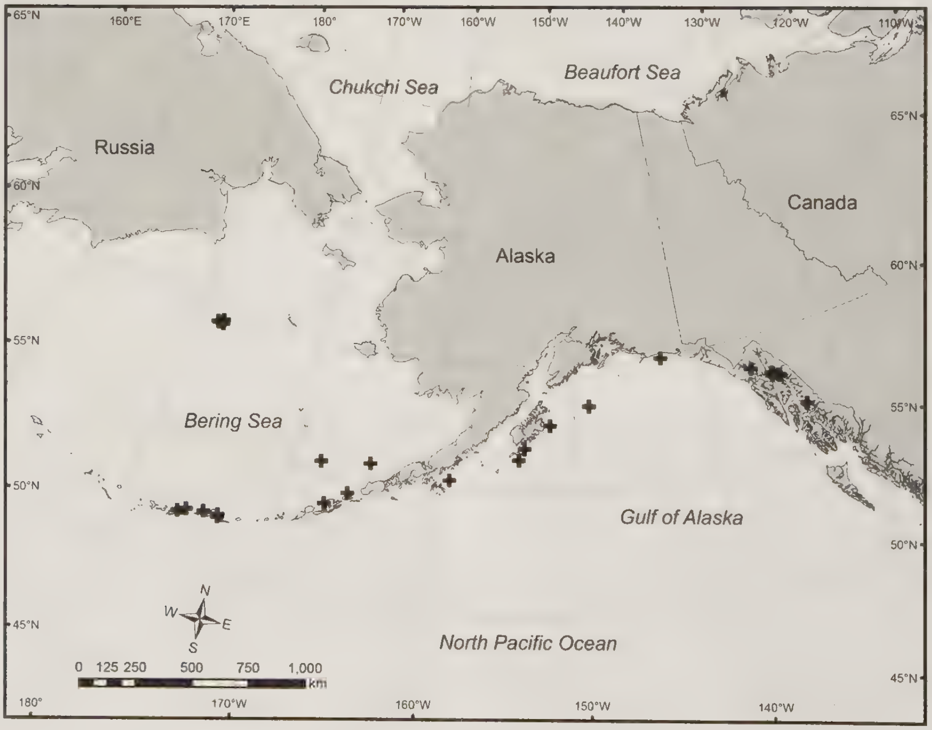
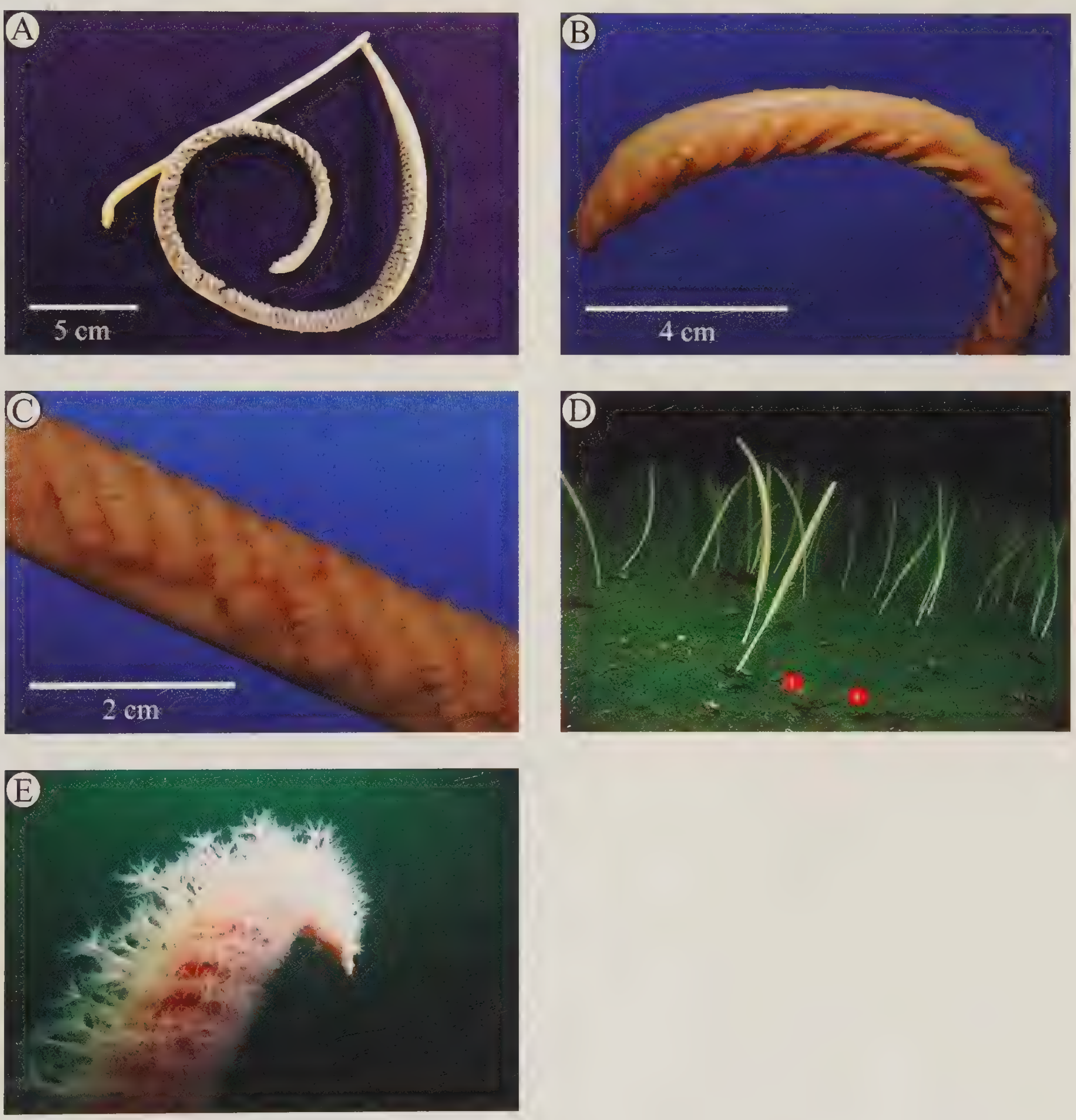


Figure 15-10

A map of the North Pacific Ocean showing the distribution of *Balticina willemoesi* (+) in Alaska waters.

15 m depth in Howe Sound, southern British Columbia (McDaniel[6]).

Photos A) A preserved (in ethanol) whole *B. willemoesi* colony (USNM 1206340) collected southwest of the Columbia River Basin, Oregon, at a depth of 529 m. B) A close-up lateral view (tip of the rachis) of a fresh *B. willemoesi* specimen collected in Pribilof Canyon, eastern Bering Sea, at a depth of 236 m. C) A close-up lateral view (central region of the rachis) of the same specimen in photo B. D) A grove of *B. willemoesi* in Auke Bay, Southeast Alaska, at a depth of 24 m. The distance between the red laser marks is 40 cm. E) A close-up view of a *B. willemoesi* colony in that same grove showing the details and arrangement of the polyps near the tip.



9. *Balticina* sp. A

Description Colonies are elongate, slender, and whip-like; the largest colonies measure up to 93 cm in height but only up to 2 cm in width. The lower sixth of the colony is typically without polyps. Leaves are alternate or random; one side of the rachis is bare. The lower peduncle is the only part of the colony that is retractable into the sediment. Colonies bend in the current, particularly at the tip where there is often little flesh, so they are a very good indicator of current strength and direction. The color of the polyps is crimson to dark pink; the color of the coenenchyme along the axis and peduncle is a lighter pink or orange.

Remarks The taxonomy of this species is unresolved so specimens should be carefully re-examined. It may be the same species as *Balticina californica* but here we list them separately due to apparent differences in zoogeography, depth distribution, habitat, and gross morphology.

This species is used as an elevated perch, presumably to suspension feed, by the deep-sea ophiuroid *Asteronyx* sp. (Fujita and Ohta, 1988) in the deeper part of its range.

Distribution Uncommon but widespread. In Alaska – scattered throughout the Gulf of Alaska, the Aleutian Islands to Amchitka Pass, and the canyons of the eastern Bering Sea (Fig. 15-11). Elsewhere – unknown.

Habitat In Alaska – typically found in groves, sometimes densely (up to 5 colonies per m^2), but occasionally singly in soft sediment (silt and sand) at depths between 253 and 1154 m. Unlike other species of *Balticina* this one is occasionally found in rockier, rougher habitats including silt-laden ledges on bedrock slopes or scarps. Video observations indicate that the species ranges to depths of at least 1391 m in the central Aleutian Islands (Stone, 2014). Elsewhere – unknown.

Photos A) A fresh whole *Balticina* sp. A colony (CAS 223760) collected in Dixon Entrance, eastern Gulf of Alaska, at a depth of 341 m. B) *Balticina* sp. A colonies photographed on Portlock Bank, western Gulf of Alaska, at a depth of about 300 m. C) The same colony in photo A just before collection. D) A close-up view of the same colony in photo C. The distance between the red laser marks in photos B and C is 10 cm.

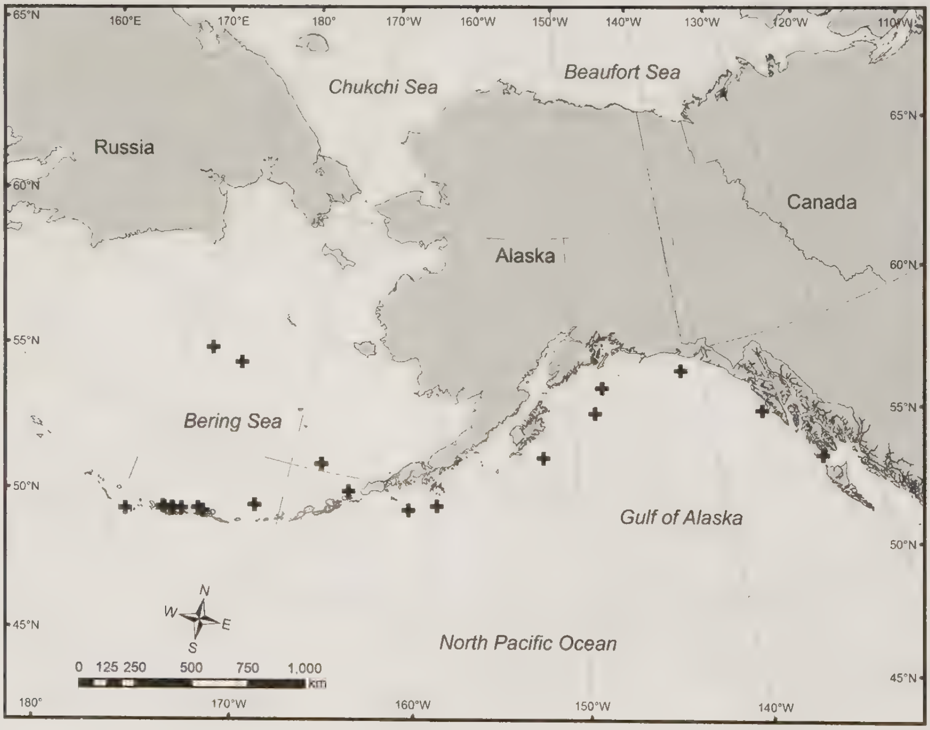
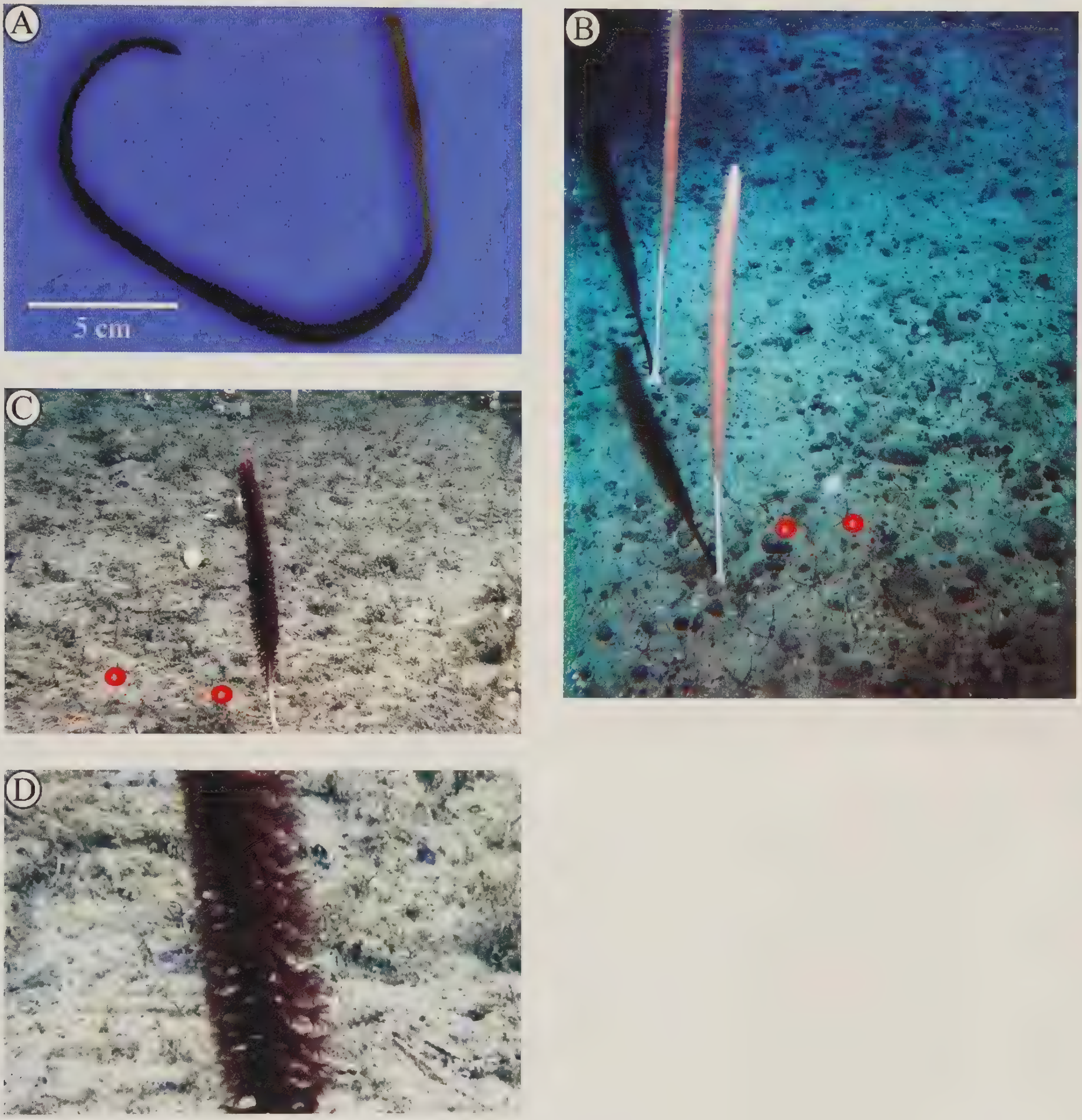


Figure 15-11

A map of the North Pacific Ocean showing the distribution of *Balticina* sp. A (+) in Alaska waters.


A
5 cm
B
C
D

Family Kophobelemnidae

(Adapted from Williams, 2005) Colonies are elongate and cylindrical or short, stout, and distinctively clavate with the distal portion typically somewhat wider than the rest of the colony. The distal end is either rounded and knob-like or distinctively pointed. Autozooids number between 2 and 50 and are arranged biserially along the rachis and not in oblique rows, or disposed on three sides of the rachis with a naked dorsal tract along the entire length of the rachis. Polyp leaves are absent. Anthocodiae are mostly non-retractile and calyces are absent. Small siphonozooids are numerous and arranged all along the rachis. Sclerites are three-flanged needles and spindles.

10. *Kophobelemnon* sp.

Description This species is represented by only two specimens (USNM 57272) collected by the U.S. Fisheries Steamer *Albatross* with a beam trawl in 1888 and identified by F. M. Bayer. These two specimens should be re-examined to determine if they represent an unknown species.

The dimensions (not including autozooids) of the two colonies are 7.2 cm in height by 4.3 cm in width and 8.4 cm in height by 5.0 cm in width. The peduncles appear to be the entire lower half of the colonies and reach close to the first polyp. The large peduncle may indicate that colonies bury deeply into the soft sediment they occupy with the first polyps close to the sediment/water interface. The rachis is noticeably enlarged (2.6 to 3.3 times larger than the peduncle) and apparently wrinkled, giving the appearance that it may become significantly inflated in life. The distal section of the rachis is blunt with an abrupt pointed tip.

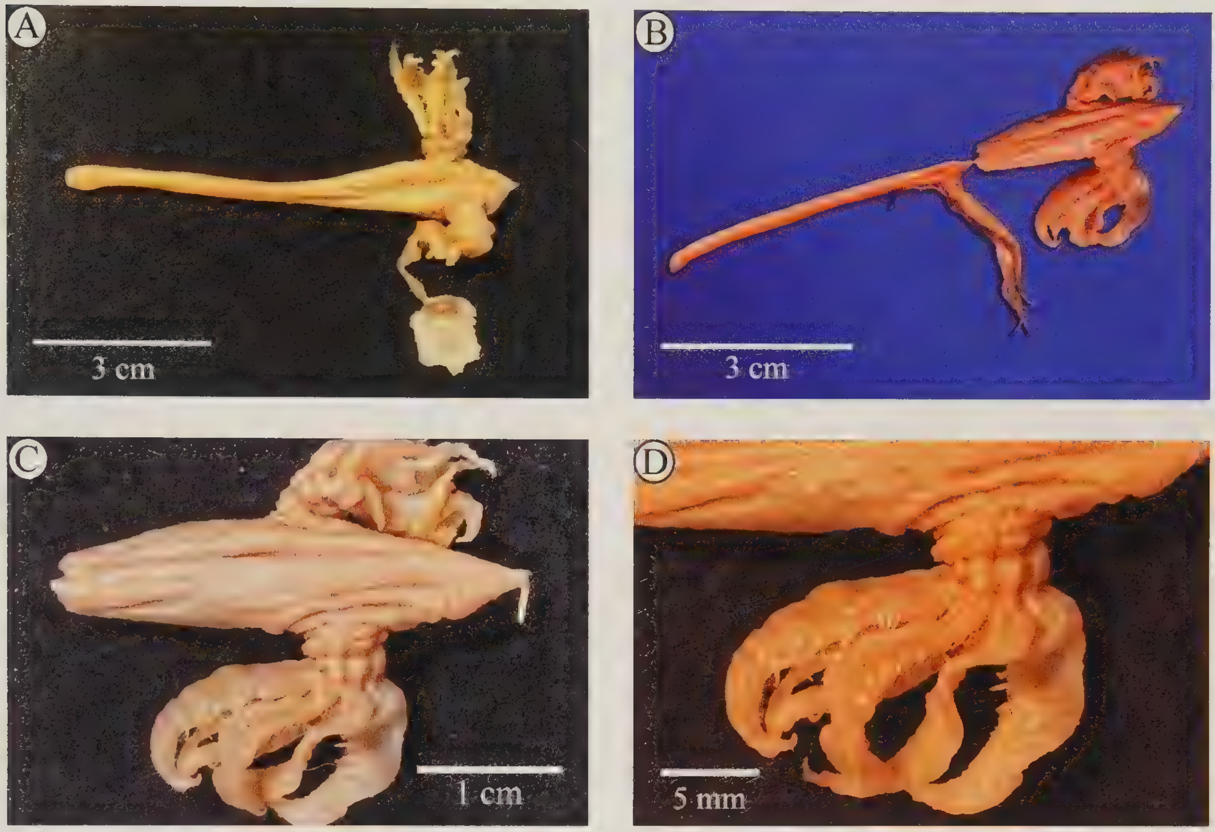
One colony has two large polyps near the top that are obliquely positioned. The larger colony has three polyps—a single unpaired polyp proximally and a pair of polyps distally. The latter specimen was broken in half upon collection so it is not possible to determine if the three polyps are possibly on three sides of the rachis. The autozooids are quite large, between 80 and 100 mm in total length, with long tentacles. Siphonozooids are numerous and densely packed on the rachis but not the peduncle or autozooids. The color of specimens preserved in ethanol is a uniform light orange; presumably colonies are a darker orange color in life.

Remarks Kophobelemnidae are typically Atlantic, Antarctic, and South Pacific species. There are several records of *Kophobelemnon hispidum* Nutting, 1912 *nomen dubium* from near Hawaii and Japan and a single specimen identified as *Kophobelemnon* sp. from British Columbia at a depth of 706 m.

Distribution Rare. In Alaska – the two specimens were collected at the same location west of Prince of Wales Island in the eastern Gulf of Alaska (Fig. 15-12). This species may be more common in the region than realized since seafloor habitats below 1000 m have been seldom sampled or visually explored. Not to mention, that colonies are small and may bury deeply in the sediment so would be difficult to collect with non-selective sampling gear. Elsewhere – unknown.

Habitat The two known specimens were collected at a depth of 2869 m where the habitat likely consisted of low-relief, soft-bottom abyssal plain.

Photos A) A preserved (in ethanol) whole *Kophobelemnon* sp. colony (USNM 57272) collected in the eastern Gulf of Alaska (west of Prince of Wales Island) at a depth of 2869 m. B) Another preserved (in ethanol) whole *Kophobelemnon* sp. colony (USNM 57272) collected at the same location and depth as the colony in photo A. C) A close-up view of the top half of the specimen in photo B. The distal end of the colony is on the right. D) A close-up view of the same specimen in photo B showing the detail of one of the polyps.


A
3 cm
B
3 cm
C
1 cm
D
5 mm

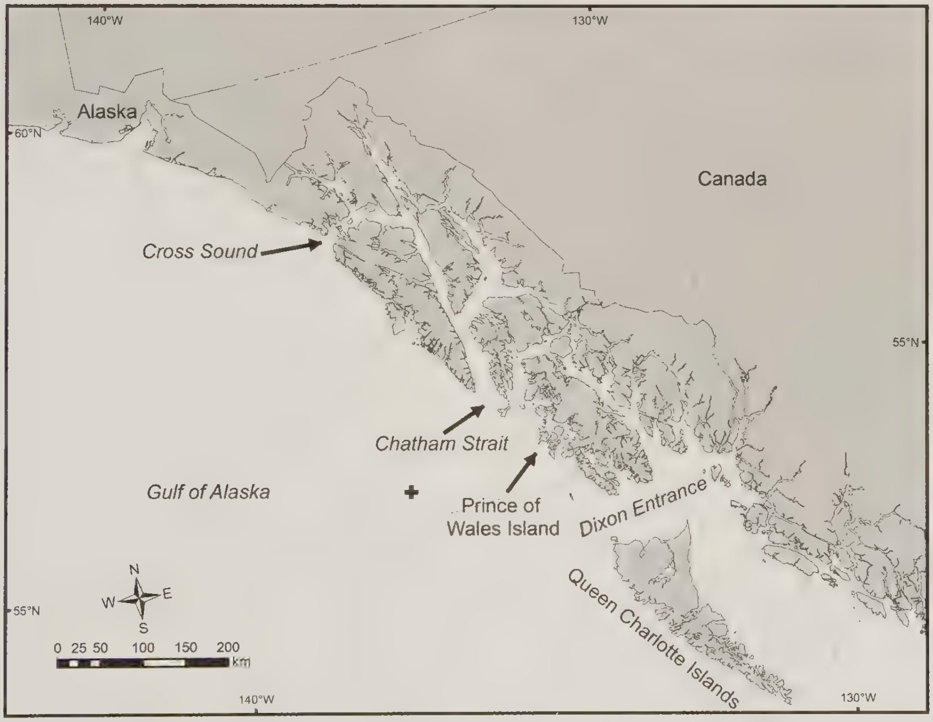

140°W
130°W
Alaska
60°N
Canada
Cross Sound
55°N
Chatham Strait
Gulf of Alaska
+
Prince of Wales Island
Dixon Entrance
Queen Charlotte Islands
N
W
E
S
55°N
0 25 50 100 150 200 km
140°W
130°W

Figure 15-12

A map of the eastern Gulf of Alaska showing the distribution of *Kophobelemnon* sp. (**+**) in Alaska waters.

Family Pennatulidae

(Adapted from Nutting, 1909 and Williams, 2005) Colonies in the genus *Pennatula* are feather-shaped with conspicuous large polyp leaves. Autozooids are arranged in one or more rows along the margins of the polyp leaves. The anthocodiae are retractile into permanent spiculiferous calyces. The calyces are tubular and typically bear eight terminal teeth. Siphonozooids are confined to the rachis between the polyp leaves. Mesozooids may be present on the rachis or on the margin of the polyp leaves opposite the autozooids. Sclerites are three-flanged needles of the calyces, inconspicuous three-flanged rods on the peduncle surface, and small ovals in the interior of the peduncle.

Colonies in the genus *Ptilosarcus* are particularly stout with kidney-shaped polyp leaves bearing sinuous margins. Autozooids are crowded on the distal margins of the polyp leaves. Anthocodiae are retractile into calyces that are mostly spiculiferous, usually with one or two indistinct to very conspicuous terminal teeth. Siphonozooids are numerous in two longitudinal tracts along the rachis but not on the polyp leaves. Sclerites are scattered over the entire surface and not confined to the borders of the leaves. Sclerites are three-flanged needles and spindles or longitudinally grooved oval-shaped plates and rods of the calyces and polyp leaves, and smooth, relatively large ovals of the peduncle.

11. *Pennatula aculeata* Danielssen, 1860

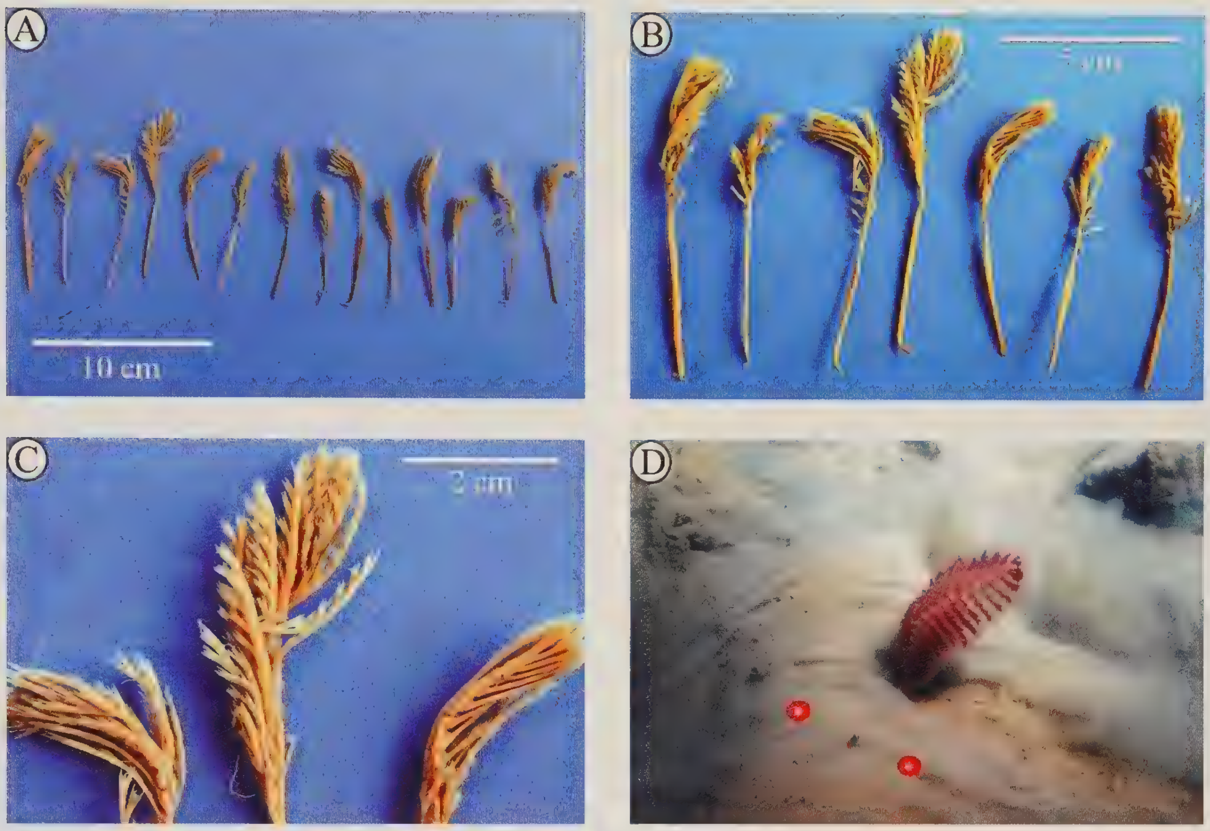
Description Colonies are bushy and similar to *Pennatula phosphorea* Linnaeus, 1758. The Alaska specimens measure up to about 9.5 cm in height and up to about 3.5 cm in width but reportedly up to 18 cm in height elsewhere. Branches are opposite, largest at the center of the rachis, and start very close to the base of the rachis near the sediment interface. The branches are up to 2 cm in length. Approximately the lower half of the colony consists of a moderately enlarged peduncle and a short section of the rachis without branches; thus the polyp leaves are almost in contact with the sediment in situ (see photo D). The color in life is unknown but crimson (see photo D) to light orange elsewhere in its geographic range and a uniform light orange in ethanol.

Remarks Study of the behavior and distribution of this species in the Gulf of Maine indicates that they have a contagious distribution with densities up to 8 colonies/m^2 (Langton et al., 1990), and the gonadal morphology and gametogenesis have also been studied from specimens collected there (Eckelbarger et al., 1998).

Distribution Rare (Fig. 15-13). In Alaska – known from only two locations: the eastern Bering Sea, sampled by the U.S. Fisheries Steamer *Albatross* (in 1890) in very deep water (2972 m), and the eastern Gulf of Alaska, west of Prince of Wales Island, also sampled by the U.S. Fisheries Steamer *Albatross* (in 1888) in very deep water (2869 m). This species may be more common than realized due to the lack of collection efforts in very deep water in the Alaska region. Elsewhere – there are only a few records in the North Pacific Ocean (the Channel Islands off central California). This is principally a North Atlantic Ocean species, ranging along the east coast of North America from Newfoundland to North Carolina.

Habitat Several records consist of very large collections indicating that this species likely forms groves. In Alaska – habitat consists of low-relief, soft sediment (silt and sand) in areas of low current and at depths between 2869 and 2972 m. Elsewhere – an extremely eurybathic species, occurring at depths between 110 and 5710 m.

Photos A) Preserved (in ethanol) whole *P. aculeata* colonies (USNM 43431) collected in Pribilof Canyon, eastern Bering Sea, at a depth of 2972 m. B) A close-up view of the same specimens in photo A. C) A zoomed-in view of the same specimens in photo A. D) A *P. aculeata* colony observed in the Gulf of Maine, Northwest Atlantic Ocean, at a depth of about 65 m. The distance between the red laser marks is about 10 cm. Photo D is courtesy of R. Langton, National Marine Fisheries Service.


A
10 cm
B
C
2 cm
D

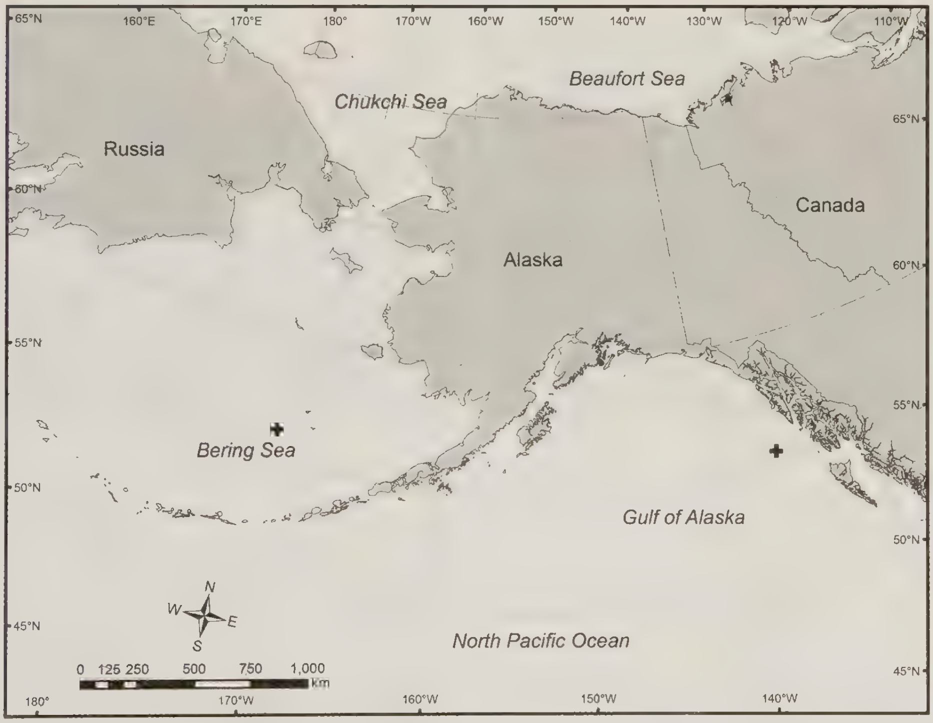

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
Canada
Alaska
60°N
55°N
Bering Sea
Gulf of Alaska
50°N
45°N
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000
km
180°
170°W
160°W
150°W
140°W

Figure 15-13

A map of the North Pacific Ocean showing the distribution of *Pennatula aculeata* (+) in Alaska waters.

12. *Pennatula* sp.

Description This taxon is known only from multiple observations made from video footage. Colonies are uniplanar, similar to *Pennatula aculeata*, but more delicate and with very different coloration. Colonies measure up to about 8 cm in height and up to about 3 cm in width. Most specimens have 16–18 pairs of branches that appear to be alternately arranged, with the largest at the center of the rachis. A short section (approximately 1 cm) of the bare rachis is exposed above the sediment, keeping the lowest branches in the water column. The color is uniform pure white which is very unusual for a genus known for colorful and even phosphorescent species.

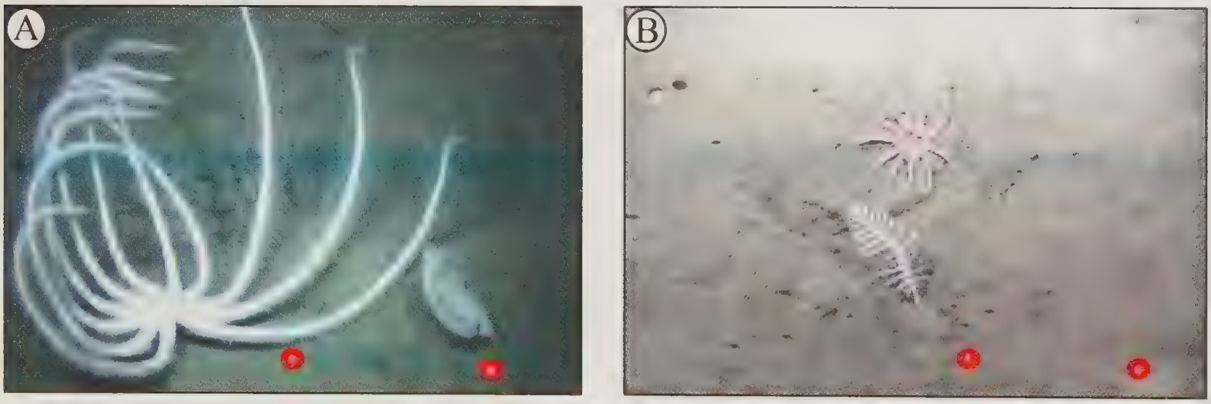
Remarks The WoRMS Editorial Board (2022) lists only 11 valid species of *Pennatula* worldwide, principally in the North Atlantic, South Pacific and Indian Oceans. Aside from our records of *P. aculeata* (see above), few *Pennatula* specimens have been collected in deep-water areas of the North Pacific Ocean. Specimens identified as *Pennatula* cf. *phosphorea californica* have been collected in British Columbia (2023 m depth) and in Monterey Bay and near the Channel Islands, northern California (1997–2710 m depth). Additionally, specimens of *P. naresi* Kölliker, 1880 have been collected near Honshu Island (Japan) at a depth of 1097 m.

This taxon differs from all the species listed above and all other pennatuloideans known to occur in Alaska and thus likely represents an undescribed species. Specimens are small and difficult to collect but future attempts of collection should be a high priority.

Distribution Uncommon. In Alaska – observed in deep water north of Atka Island, central Aleutian Islands (Fig. 15-14). Elsewhere – unknown.

Habitat Always found singly but in large, low-density patches. Habitat consists of low-relief, soft sediment (silt and sand) in areas of low current and at depths between 2239 and 2930 m.

Photos A) A *Pennatula* sp. colony (lower right) with polyps extended observed north of Atka Island, central Aleutian Islands, at a depth of 2821 m. An unknown brisingid star is at left. B) A *Pennatula* sp. colony, with polyps retracted, observed north of Atka Island at a depth of 2930 m. An unknown holothurian is burrowed above the sea pen. The distance between the red laser marks in both photos is 10 cm.



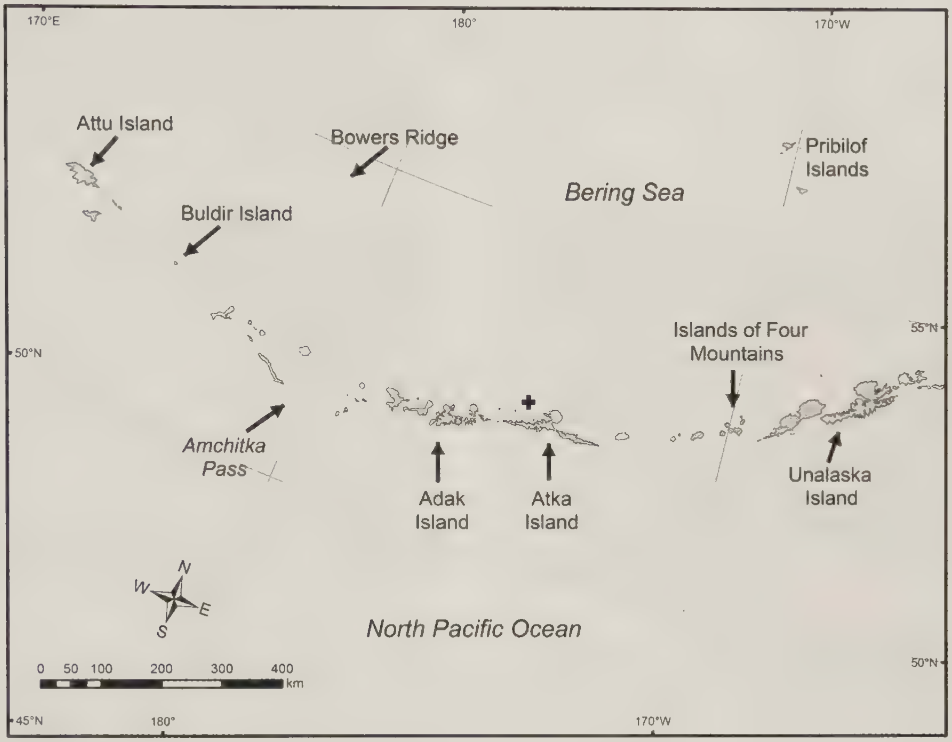

170°E
180°
170°W
Attu Island
Bowers Ridge
Bering Sea
Pribilof Islands
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Atka Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 15-14

A map of the Aleutian Islands showing the distribution of *Pennatula* sp. (+) in Alaska waters.

13. *Ptilosarcus gurneyi* (Gray, 1860)

Description Colonies are bushy and resemble a quill pen. Colonies measure to 50 cm or more in height and 25 cm or more in width when fully inflated (i.e., expanded). The anthocodiae are retractile into calyces with two conspicuous terminal teeth. Siphonozooids are numerous but not arranged in clumps. Colonies are capable of slow but complete withdrawal into the sediment such that only the tip of the retracted colony is visible in a depression. The color of colonies in life and in ethanol is a uniform bright to medium orange.

Remarks The skeletal axis is composed almost entirely of high-magnesium calcite (12.0 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data). This species is preyed upon by the nudibranch *Tritonia diomedea* that often spawns its egg masses (long ribbon-like strings that are the same color as the sea pens) around the base of the colony or immediately near it.

Distribution Common and locally abundant. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, the central and western Gulf of Alaska, and the Aleutian Islands west to at least Buldir Island (Fig. 15-15). Conspicuously absent from the eastern Bering Sea. Also absent from the seamounts in the Gulf of Alaska Seamount Province, likely because all summits are deeper than the range of this species. Elsewhere – found south along the west coast of North America to southern California. There are six, highly geographically disjunct records from the Philippines (NMNH 43427) that should be re-examined.

Habitat In Alaska – found in groves, sometimes densely, rarely singly in soft sediment (sand and silt) at depths between 3 and 274 m. Juveniles (<6 cm in height) are often observed in shallower water (<10 m in depth) upslope from groves of adult colonies. Elsewhere – found in soft-sediment areas at depths of 16 to 293 m.

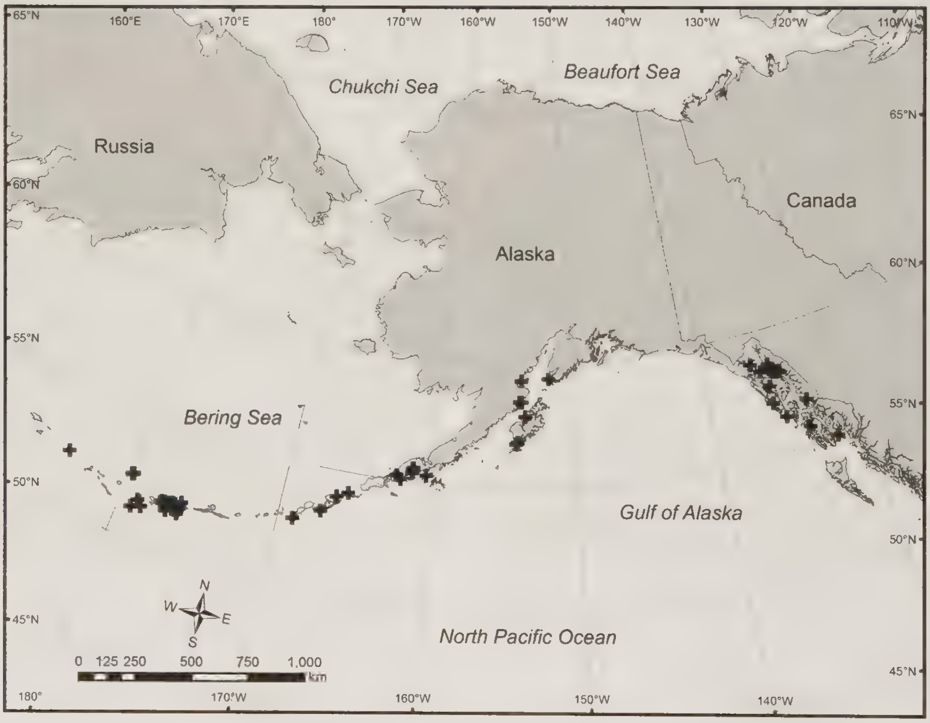
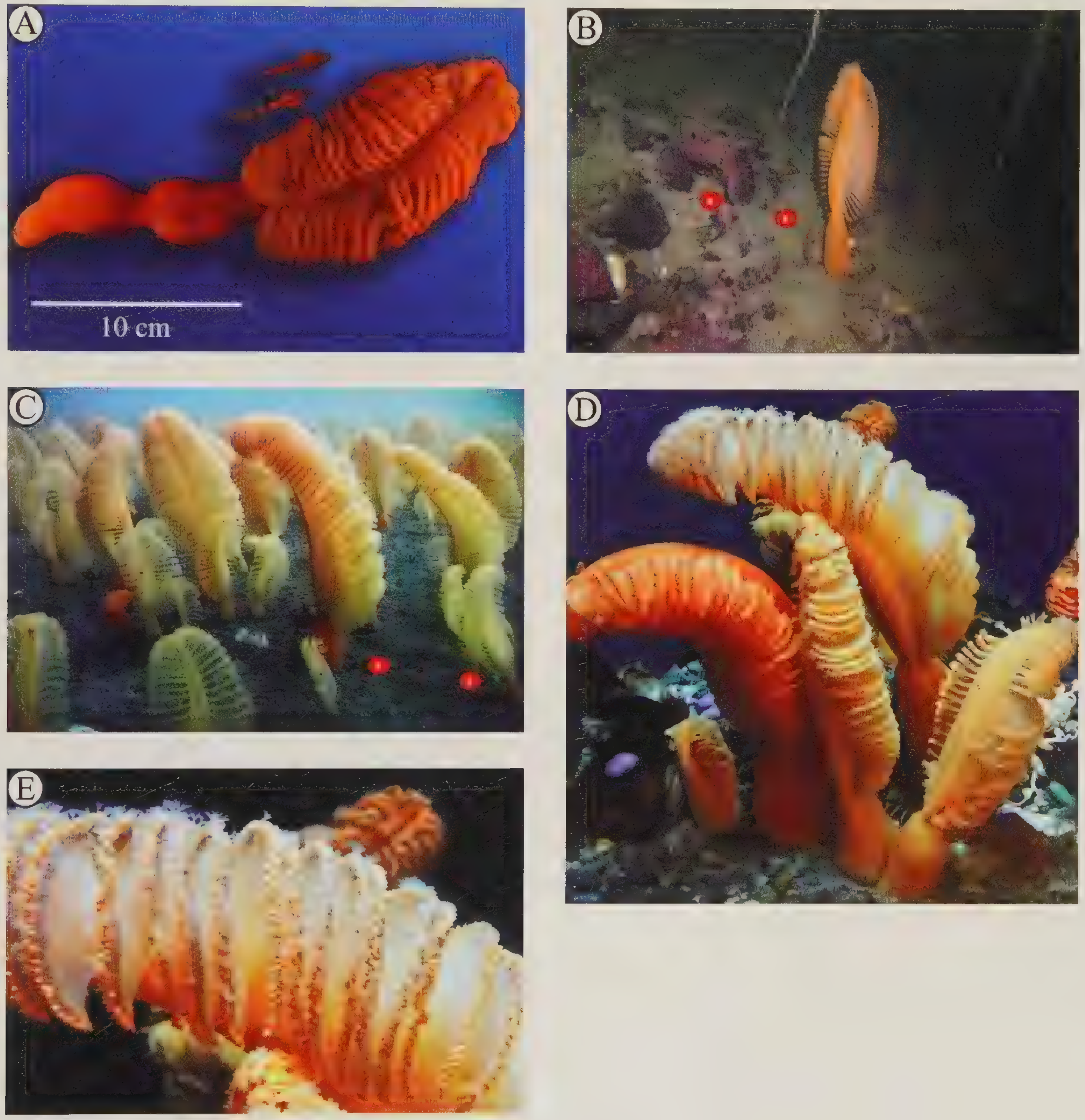

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
Russia
60°N
Canada
Alaska
65°N
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 15-15

A map of the North Pacific Ocean showing the distribution of *Ptilosarcus gurneyi* (+) in Alaska waters.

Photos A) Juvenile and adult *Ptilosarcus gurneyi* specimens collected in Glacier Bay, Southeast Alaska, at a depth of 15 m. B) A *P. gurneyi* colony photographed in Glacier Bay at a depth of 18 m. Several small *Balticina willemoesi* are visible in the background. C) A grove of *P. gurneyi* colonies near Auke Bay, Southeast Alaska, at a depth of 16 m. Photo credit: P. Malecha, National Marine Fisheries Service. D) *Ptilosarcus gurneyi* colonies held in a laboratory aquarium for study. E) A close-up view of the largest *P. gurneyi* colony in photo D. The distance between the red laser marks in photos B and C is 10 cm.



Family Protoptilidae

(Adapted from Nutting, 1909 and Williams, 2005) Colonies are slender and elongate, never clavate, with autozooids in one to three longitudinal rows along opposite sides of the rachis. Individual autozooids may be scattered on the rachis between the lateral rows. Polyp leaves are absent. Anthocodiae are retractile into spiculated calyces which usually have three to eight terminal teeth. Siphonozooids are two to three times more abundant than autozooids and are mostly concentrated near them. Sclerites of the tentacles, calyces, rachis, and peduncle are three-flanged needles, spindles, rods, and ovals.

14. *Protoptilum* sp.

Description Colonies are elongate, whip-like, and measure up to 44 cm in height. The rachis is quite slender, measuring to only about 6 mm in width, but relatively stiff and flexible. Larger colonies bend slightly in the current. The lower 30–40% of the axis is without polyps. Only the small, slightly bulbous peduncle is retractable into the sediment. The color of the flesh is very light orange to creamy orange and slightly lighter along the axis.

Remarks The taxonomy of this species is unresolved and this taxon as we present it may represent more than one species. Museum specimens should be carefully re-examined and all specimens collected during surveys and research expeditions should be retained for study.

There are only seven valid species of *Protoptilum* worldwide (WoRMS Editorial Board, 2022). They are principally North Atlantic Ocean taxa ranging along the east coast of North America from the Labrador Sea (Greenland) to Florida. Aside from our records of *Protoptilum* from relatively shallow-water areas of Alaska, North Pacific Ocean records include: 1) *P. orientale* Nutting, 1912 from the Pacific Ocean side of Honshu, Japan, at depths between 472 and 515 m, and 2) *Protoptilum* sp. from Japan (148 m depth), British Columbia (940 m depth), and Oregon (137–1946 m depth).

Larger colonies are often used as an elevated feeding platform by the common basket star (*Gorgonocephalus eucnemis*) and also occasionally host smaller ophiuroids.

Distribution Uncommon but locally abundant. In Alaska – Southeast Alaska (Glacier Bay) and the western Gulf of Alaska from south of Prince William Sound to south of Kodiak Island (Fig. 15-16). Elsewhere – unknown.

Habitat In Alaska – typically found in small patches or groves, sometimes densely, rarely singly in soft sediment (sand and silt) and at depths between 18 and 142 m.

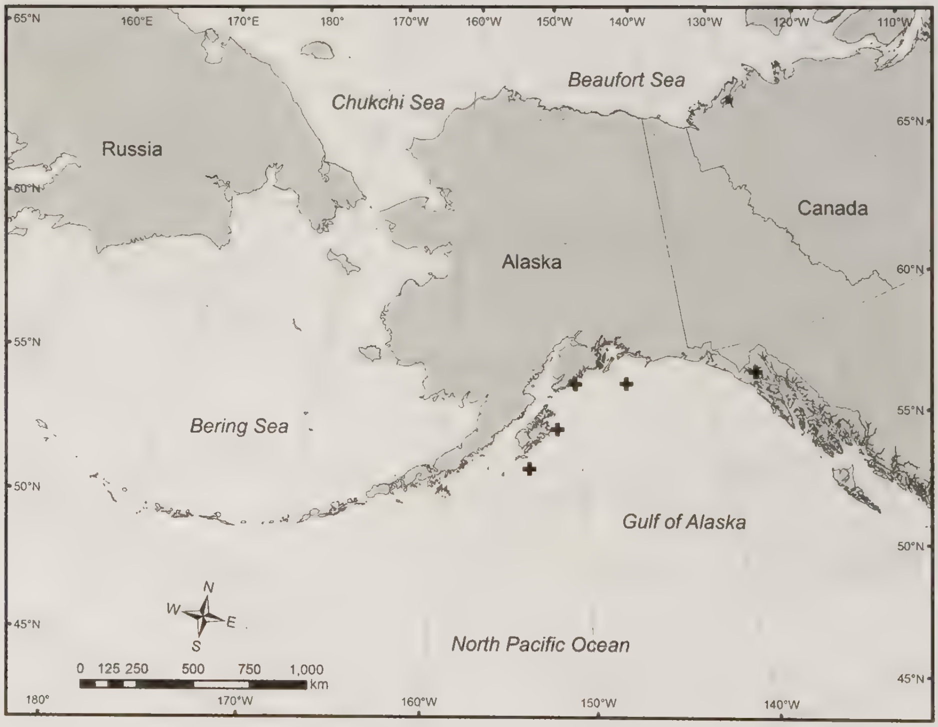
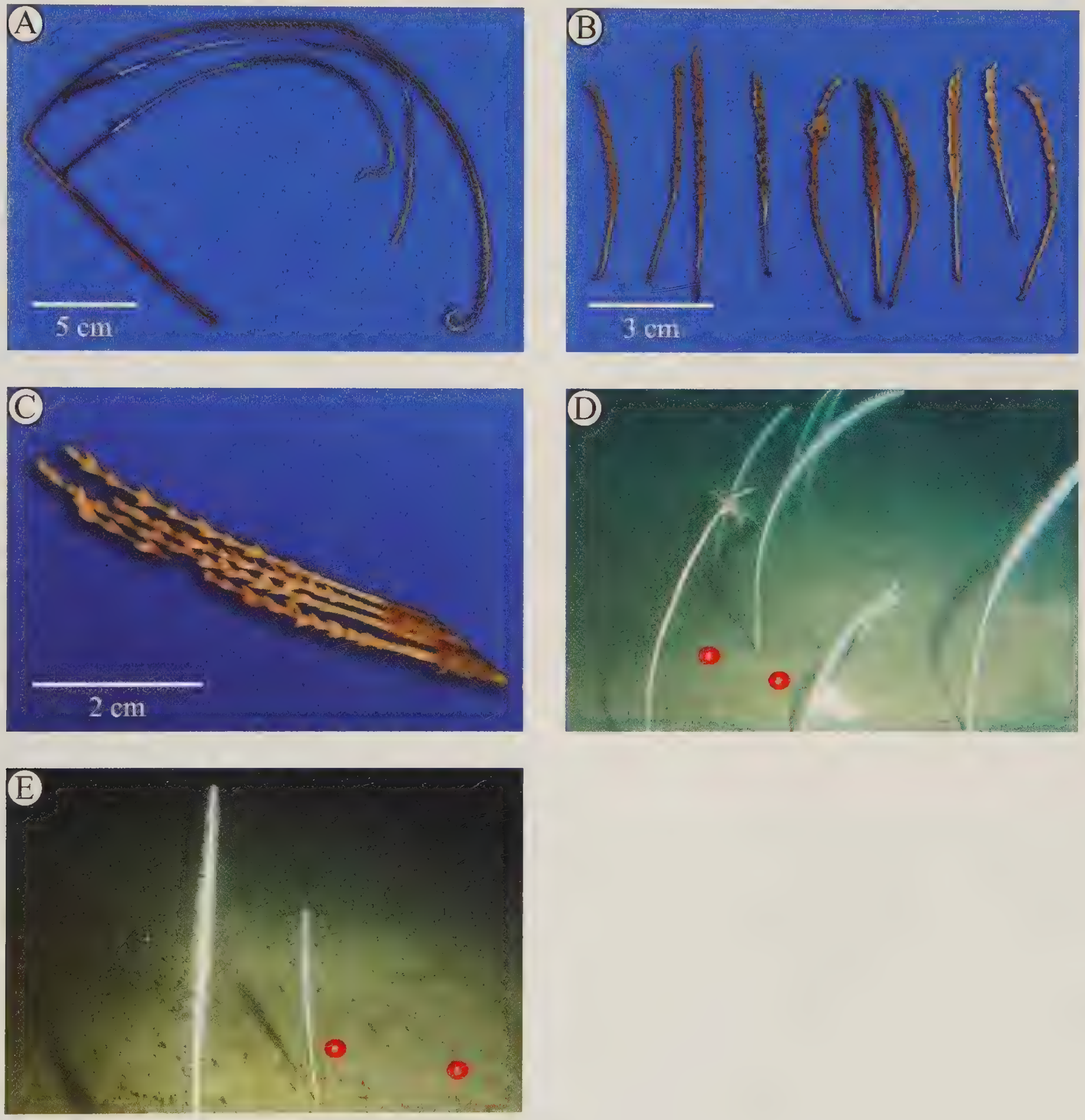


Figure 15-16

A map of the North Pacific Ocean showing the distribution of *Protoptilum* sp. (+) in Alaska waters.

Photos A) Large preserved (in ethanol) whole *Protoptilum* sp. colonies (CAS 222956) collected in Chiniak Gully, western Gulf of Alaska, at a depth of 142 m. B) Small preserved (in ethanol) whole *Protoptilum* sp. colonies (CAS 222955) collected in Two-headed Gully, western Gulf of Alaska, at a depth of 127 m. C) Fresh small *Protoptilum* sp. specimens collected in Glacier Bay, Southeast Alaska, at a depth of 18 m. D) A grove of large and small *Protoptilum* sp. colonies observed in Chiniak Gully at a depth of 140 m. E) Several large *Protoptilum* sp. colonies observed in Chiniak Gully at a depth of 130 m. The distance between the red laser marks in photos D and E is 10 cm.



Family Stachyptilidae

(Adapted from Williams, 2005) Colonies are stout and clavate or slender; firm or spongy in texture. Polyp leaves are absent and the autozooids are arranged in oblique rows in two longitudinal series along the rachis. Each row is situated alternately to a corresponding row on the other side of the rachis. Anthocodiae (about three per row) are retractile into densely spiculated calyces. Calyces are conspicuously toothed, generally with two or three long terminal teeth. Siphonozooids are mostly in oblique rows between the rows of autozooids and often have calyces formed by fan-shaped arrays of sclerites. Sclerites are three-flanged needles and spindles of the polyp calyces and rachis and oval- or rod-shaped plates in the peduncle.

15. *Stachyptilum superbum* Studer, 1894

Description (Original description from Studer, 1894) The type specimen has the appearance of a wheat "cob" and is 200 mm in height with the lower 58–60 mm of the stalk (the stem) lacking polyps. The colony is cylindrical, a little swollen towards its base, and terminating in an obtuse tip. The rachis is thicker than the stem; the dorsal part is very tightly covered with calyces that are cylindrical and long in shape (5–6 mm) with openings that cover the bases of the superimposed calyces. The calyces are arranged in 34 (from base to tip) slanted rows of four or five on each side. The calyces are armed with long, spiniform sclerites, which project a little beyond the opening and form two or three prominent teeth. The ventral part of the rachis contains a narrow section bare of polyps and a deep furrow runs along its entire length. On both sides of this furrow the ventral part is covered with small zooids, which are tubular and project a little on the surface; they have at their base a crown of sclerites. The axis is cylindrical, calcitic, elastic in consistency, and ends in a thin net towards the base. The color of the polyps is purple-brown with a white rachis.

(Adapted from Nutting, 1909) Colonies are to up to 170 mm in height with the lower 81 mm of the stalk without polyps. There is a relatively prominent terminal bulb and a swelling above the bulb. The ventral surface of the rachis has a deep, even, undulating grove. Polyps almost completely surround the rachis. Calyces are terete, rather slender (3.5–5.0 mm in length by 1.25 mm in width) and in four rows forming an oblique series. The autozooids are dark and well defined and present in a row on either side of the ventral groove. They are particularly conspicuous distally, and siphonozooids appear in small rows lateral from the main rows and in between the calyces on the dorsal side of the rachis. The sclerites are large, needle-like, and placed longitudinally on the walls of the calyces. The ventral groove is devoid of sclerites, in marked contrast to the rest of the rachis.

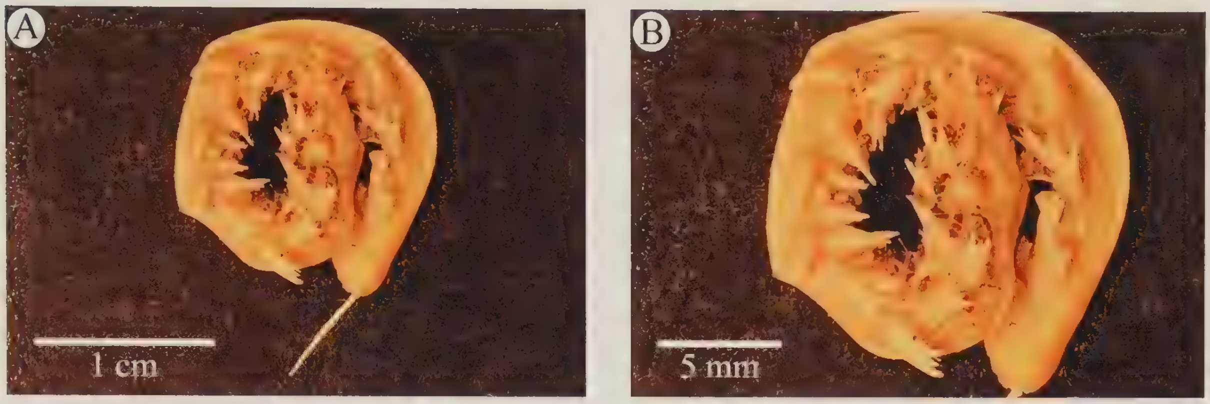
The single known Alaska specimen (USNM 1206296) is much smaller, about 59 mm in height and about 5 mm in width at its widest point. The specimen appears to be complete but the intact axis has apparently protruded through the base of the peduncle as a result of contraction of the flesh during long-term preservation in ethanol. The color in ethanol is a uniform pale orange.

Remarks Four of the five genera in the family Stachyptilidae are found in the Pacific Ocean. *Stachyptilum* is a small, obscure genus of only five species, including two of uncertain status.

Distribution Rare. In Alaska – known from only a single specimen (USNM 1206296) collected on Petrel Bank in the central Aleutian Islands (Fig. 15-17). Elsewhere – occurs along the Pacific Coast of the Americas (northern Oregon south of the Columbia River Basin, Channel Islands and Monterey Bay in California, and central Mexico to Chile). The type specimen was collected off the coast of Panama at a depth of 384 m.

Habitat In Alaska – likely soft-bottom (sand and silt) habitat at a depth of 388 m. Elsewhere – found at depths between 48 and 1238 m; a single specimen was collected from an area of green mud in Monterey Bay at a depth of 69 m and Nutting (1909) reports another specimen collected in Monterey Bay at a depth of 48 m. Several of the deeper-water collections with trawls consisted of many specimens, indicating that this species has a patchy distribution and possibly even forms small groves.

Photos A) A preserved (in ethanol) whole *Stachyptilum superbum* specimen (USNM 1206296) collected on Petrel Bank, central Aleutian Islands, at a depth of 388 m. Note that the axis has protruded through the peduncle. B) A close-up view of the same specimen in photo A.



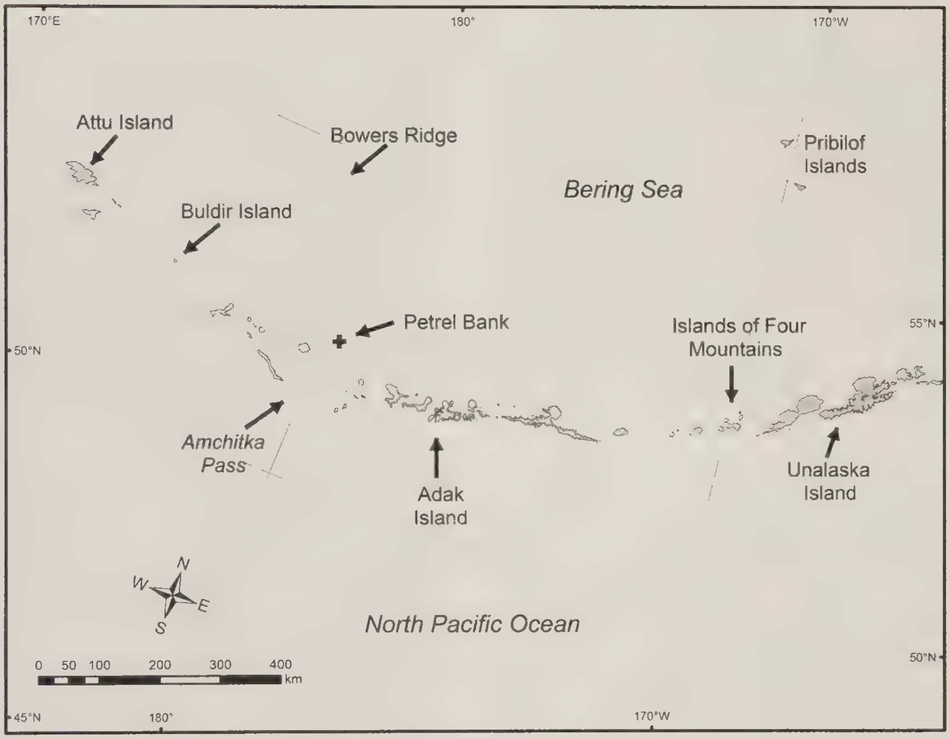

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400
km
50°N
45°N
180°
170°W

Figure 15-17

A map of the Aleutian Islands showing the distribution of *Stachyptilum superbum* (+) in Alaska waters.

Family Umbellulidae

(Adapted from Williams, 2005) Colonies have very large polyps radiating from a cluster (or crown) at the end of a long, slender stalk. Polyp leaves are absent and the autozooids are restricted to the crown of 1–40 polyps. Anthocodiae are non-retractile and there are no calyces. Siphonozooids are present at the base of the autozooids and below the crown on the upper part of the stalk. Sclerites are present in only a few species and if so are distributed in the tentacles, wall of the autozooids, and peduncle. Sclerites are three-flanged or round spindles, rods, ovoid rods, and needles.

Umbellula is the only genus in the family but there are 24 valid species recognized worldwide (WoRMS Editorial Board, 2022). *Umbellula* appear to be widely distributed in the northern North Pacific Ocean but only a few specimens have been identified to species and seemingly inaccurately.

16. *Umbellula* sp.

Description Colonies are elongate, whip-like, and have a very narrow but rigid axis. The peduncle is slightly enlarged and is only about 15–20% of the colony length. Colonies may have between 3 and 20 large polyps terminally on the crown, and there seems to be little relationship between the number of crowns and colony height. The anthocodiae with extended polyps may reach 5 cm in length. The largest colonies are up to 35 cm in height and the crown is up to 10 cm in width. The color in life is light orange to white with purplish polyps and often crimson tentacles; the color in ethanol is dark golden brown to light brown.

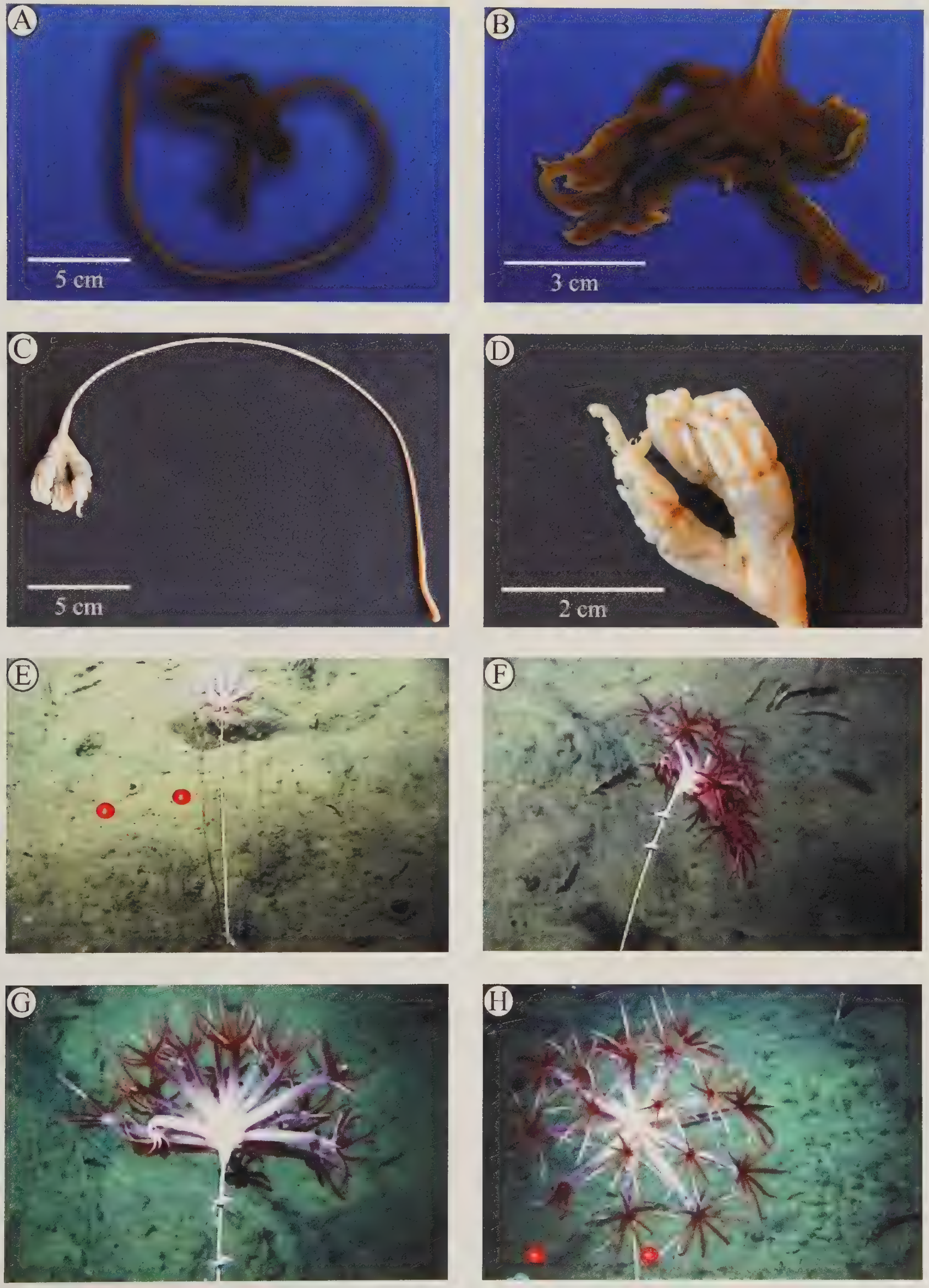
Remarks The taxonomy of this species is unresolved and it may represent one or more undescribed species or may be the cosmopolitan *Umbellula lindahli* Kölliker, 1875. Further examination of all specimens from the region is warranted.

Associates include the large amphipod *Amathillopsis annectens* (Watling and Stone[7]) that clings to the stalk (see photos F and G). A large, solitary hydroid, possibly *Branchiocerianthus imperator* reported from very deep water (3422 m) in the region of Japan, was observed at several locations on Derickson Seamount and the surrounding abyssal plain in the western Gulf of Alaska and can easily be confused with *Umbellula* (see photo I).

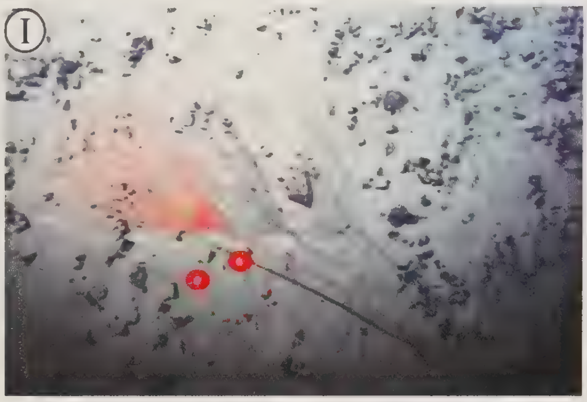
Distribution Uncommon but widespread (Fig. 15-18). In Alaska – eastern and western Gulf of Alaska, central Aleutian Islands including Bowers Ridge that extends northward into the eastern Bering Sea, and Giacomini and Derickson Seamounts in the Gulf of Alaska Seamount Province. Elsewhere – North Pacific Ocean records of *Umbellula* range from British Columbia to Oregon. *Umbellula lindahli* appears to be cosmopolitan with specimens reported principally from the North Atlantic Ocean (Baffin Bay and off the east coast of North America), Gulf of Mexico, Caribbean Sea, South Atlantic Ocean (off the east coast of South America), the Southern Ocean, and South Pacific Ocean (New Zealand). The species is also reported in the North Pacific Ocean off California and Oregon. *Umbellula ioma* Nutting, 1909 (an unaccepted species according to WoRMS Editorial Board [2022]) is reported from the Sea of Okhotsk, Russia.

Habitat In Alaska – occurs singly in soft sediment (silt and sand) at depths between 840 and 4656 m (the deepest record in the North Pacific Ocean). Video observations indicate that the species ranges at depths between 2546 and 2947 m in the central Aleutian Islands (Stone, 2014). This species is often found in mixed groves with the sea pens *Anthoptilum grandiflorum, Anthoptilum* sp. C, and the chrysogorgiid *Radicipes stonei*. Elsewhere – extremely eurybathic. *Umbellula* species reported from the northern North Pacific Ocean range at depths between 352 and 4062 m.

Photos A) A preserved (in ethanol) whole *Umbellula* sp. colony (CAS 222947) collected south of the Trinity Islands, western Gulf of Alaska, at a depth of 840 m. B) A close-up view of the crown on the same specimen in photo A. C) A preserved (in ethanol) whole *Umbellula* sp. colony (USNM 1081174) collected on Derickson Seamount at a depth of 4656 m. D) A close-up view of the colony terminus on the same specimen in photo C. The colony has three large polyps; numerous siphonozooids are visible at the base of the crown. E) An *Umbellula* sp. colony observed north of Atka Island, central Aleutian Islands, at a depth of 2840 m. The distance between the red laser marks is 20 cm. F) A close-up view of the same colony in photo E. Note the two large amphipods, *Amathillopsis annectens*, clinging to the stalk. G) A zoomed-in view of the same colony in photo E. H) An *Umbellula* sp. colony observed north of Atka Island at a depth of about 2830 m. The distance between the red laser marks is 10 cm. I) A large, solitary hydroid, possibly *B. imperator*, at a depth of 4568 m on Derickson Seamount. The distance between the red laser marks is 20 cm.


A
5 cm
B
3 cm
C
5 cm
D
2 cm
E
F
G
H

16. *Umbellula* sp. (continued)



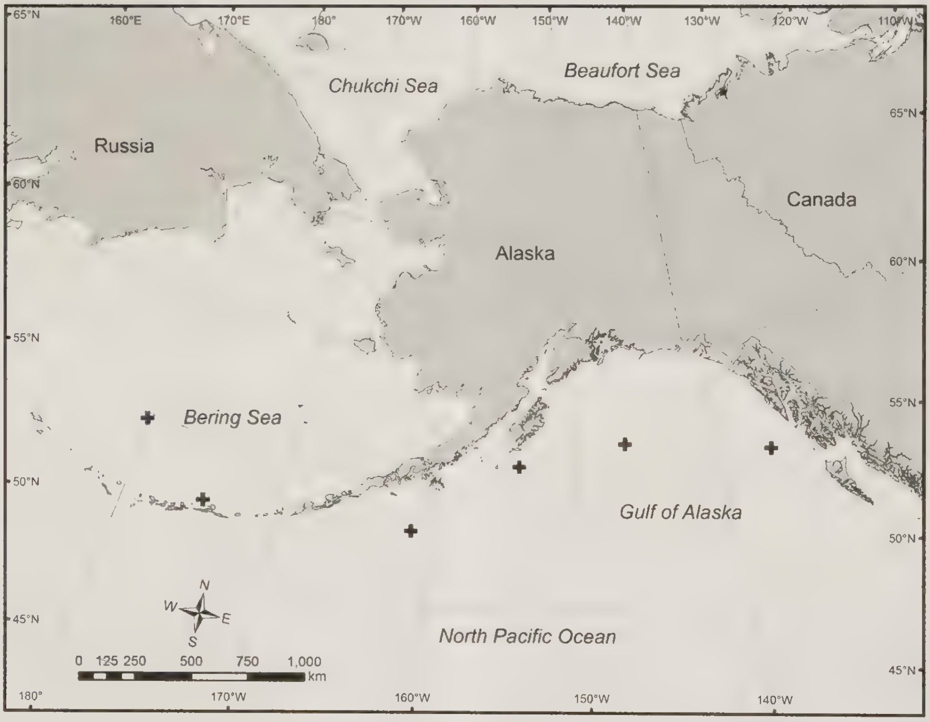

Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 15-18

A map of the North Pacific Ocean showing the distribution of *Umbellula* sp. (+) in Alaska waters.

Family Veretillidae

(Adapted from Williams, 1995) Colonies are cylindrical, capitate, clavate, or elongate with an erect rachis not lying on the substrate. Polyp leaves are absent. The autozooids are without calyces and distributed evenly on all sides of the rachis or the proximal portion of the rachis has a single longitudinal furrow or *V*-shaped region devoid of polyps. Anthocodiae are retractile directly into the rachis; there are no calyces. Siphonozooids are densely positioned between the autozooids. Sclerites are present but may be absent in the polyps.

17. *Cavernularia vansyoci* Williams, 2005

Description (Adapted from Williams, 2005) Colonies are clavate and the largest colonies measure up to 57 mm in height and up to 37 mm in width. The stalk or peduncle widens noticeably about halfway up the colony. The color of the preserved holotype is pale orange to creamy orange throughout, but live specimens are likely light orange.

The polyps of the preserved holotype are all completely retracted. They are flush with the surface of the rachis and nowhere do they extend past the surface. Calyces are absent. The polyps and polyp walls contain minute sclerites, similar to the sclerites of the superficial coenenchyme and peduncular interior. As in the coenenchymal tissues, these sclerites can only accurately be detected at microscope magnifications at 400× or higher. The sclerites are smooth spindles, rods or ovals, and are all colorless.

The sclerite complement is composed entirely of very small ovals (0.003–0.007 mm in length). The shape of these sclerites is only accurately discernable at microscopic magnifications of 400× or more. They vary in shape from rounded-rectilinear to oval, more-or-less round, or elliptical. Some sclerites are irregular in shape. These minute sclerites are relatively dense in all parts of the colony examined, including the coenenchyme of the surface of the rachis and peduncle, as well as the interior of the colony, but seem to be less densely distributed in the anthocodiae and polyp walls.

Remarks *Cavernularia* is a relatively large genus with 19 species currently recognized worldwide (WoRMS Editorial Board, 2022). Most species are found in the Indo-Pacific region and Atlantic Ocean including the Mediterranean Sea. Only two other species are known from the North Pacific Ocean: *Cavernularia habereri* Moroff, 1902 and *Cavernularia glans* Kölliker, 1872, both reported along the east coast of Asia.

This species is known from only two collected specimens. Colonies are quite small and inconspicuous so they might be easily overlooked when observed in situ and rarely retained when encountered by bottom trawls, a major source of collected specimens in Alaska.

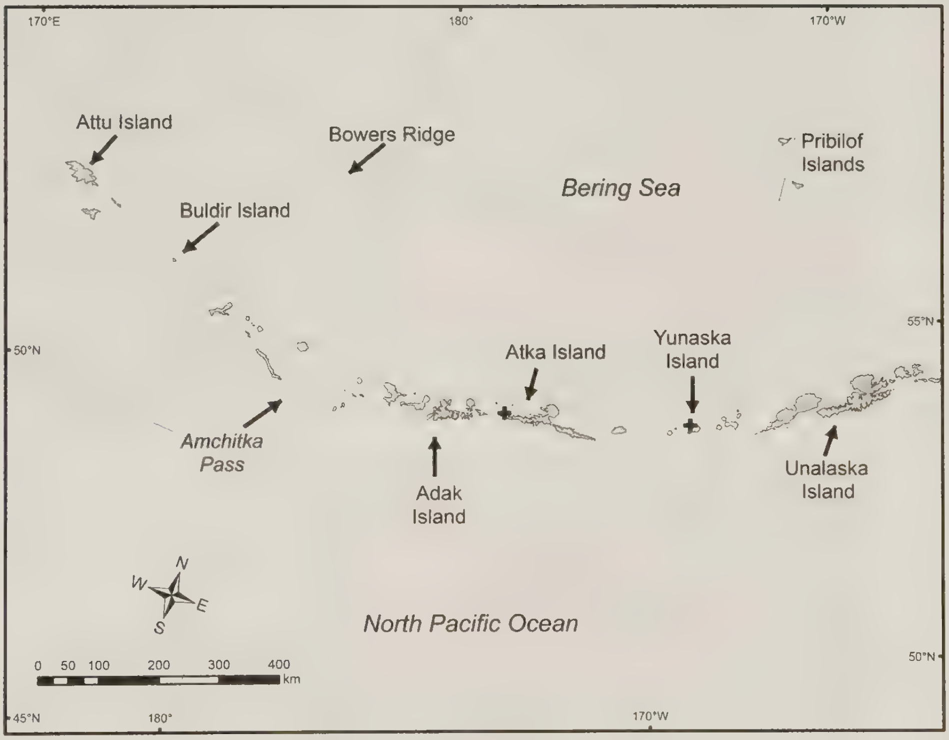


Figure 15-19

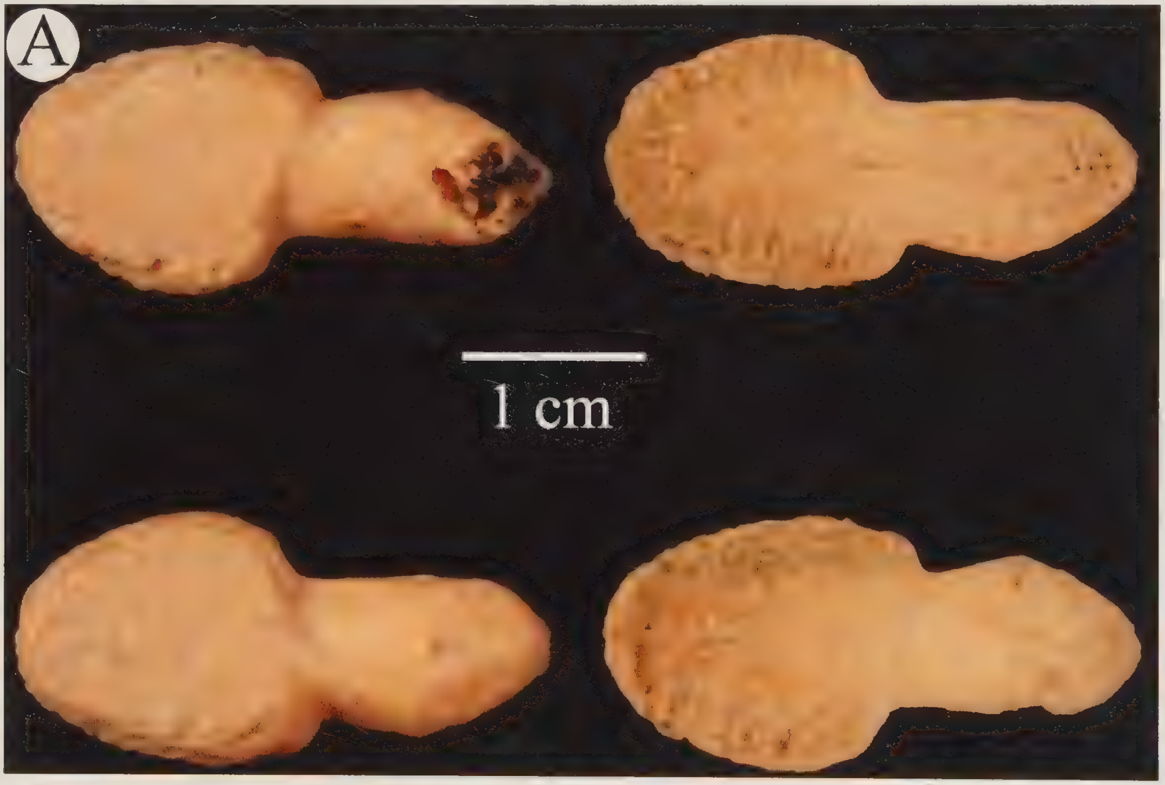
A map of the Aleutian Islands showing the distribution of *Cavernularia vansyoci* (+) in Alaska waters.

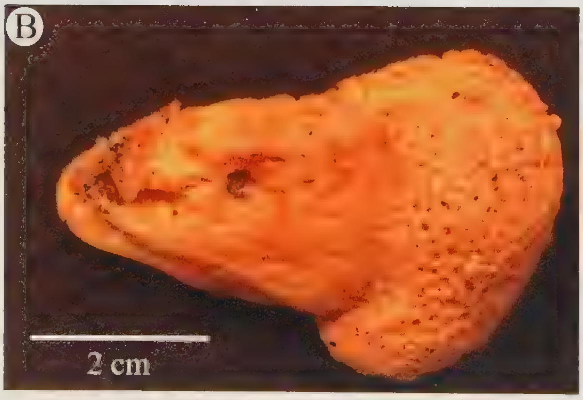
Preserved *Cavernularia vansyoci* specimens can easily be mistaken for the soft coral *Alcyonium* sp. without careful examination to confirm the presence of siphonozooids between the autozooids and to verify that the lower part of the colony is a peduncle and not a holdfast.

Distribution Rare (Fig. 15-19). In Alaska – known only from the Aleutian Islands, north of Yunaska Island to off the northwestern tip of Atka Island (the type locality). Elsewhere – not reported.

Habitat In Alaska – soft-sediment (likely coarse sand and fine pebbles) habitat at depths between 94 and 126 m.

Photos A) The preserved (in ethanol) *C. vansyoci* holotype (CAS 168894; whole colony) collected north of Atka Island, central Aleutian Islands, at a depth of 94 m. The whole colony was cut longitudinally into two halves. External and internal views of both halves are at left and right, respectively. The figure is reprinted with permission from Williams (2005). B) A preserved (in ethanol) whole *C. vansyoci* colony (USNM 100721) collected north of Yunaska Island, eastern Aleutian Islands, at a depth of 126 m. The widened top of this colony was likely compressed somewhat laterally during preservation.





Family Virgulariidae

(Adapted from Williams, 2005) Colonies in the genus *Virgularia* are long, slender, and often vermiform or more stout, robust, and rigid. The calcareous axis extends beyond the tip of the rachis in some species. Polyp leaves are relatively short, and often congested or with sections of bare rachis between adjacent leaves. Tubular autozooids are fused for most of their length to form relatively thin polyp leaves, 3–100 autozooids per leaf. Anthocodiae are retractile into the bulbous fleshy base of the polyps, thus forming calyx-like mounds. Siphonozooids are sparsely distributed on the polyp leaves below the free parts of the autozooids or more commonly on the rachis between polyp leaves. Sclerites in *Virgularia* are virtually absent except for minute oval bodies in the interior of the peduncle.

18. *Virgularia bromleyi* Kölliker, 1880

Description The original description by Kölliker (1880) is rudimentary and based on a single fragmented colony. The polyps were described as nearly sessile with very small pinnules. The pinnules are nearly opposite with each about 4 mm apart. The rachis has lateral zooids disposed at the base of the leaves in one single row of three individuals. The sclerites are very small ordinary needles and are scantily distributed in the stalk, rachis, and the polyp tentacles.

The original description of 13 specimens of *Halisceptrum cystiferum* Nutting, 1909 (now synonymized with *Virgularia bromleyi*) indicates the largest colonies are to 120 mm in length with the lower 65 mm of the stalk without leaves. The terminal bulb is a prominent bladder-like expansion and the ventral side of the rachis has a distinct groove. The pinnae are very short, and so closely set that the polyps appear to be attached directly to the stem. There are approximately 32 pairs of pinnae including the rudimentary ones. There are four or five large (compared to the pinnae themselves) polyps per pinna and they appear to be only partially retractable. Zooids were noted as absent. Sclerites were not observed by Nutting, but he noted that if present they were rare and very small—an observation that prompted him to place his "new species" in the genus *Halisceptrum*.

None of the five known Alaska specimens (USNM 43778) appear to be intact but the largest colony is likely about 150 mm in length. The color in ethanol is uniform light orange.

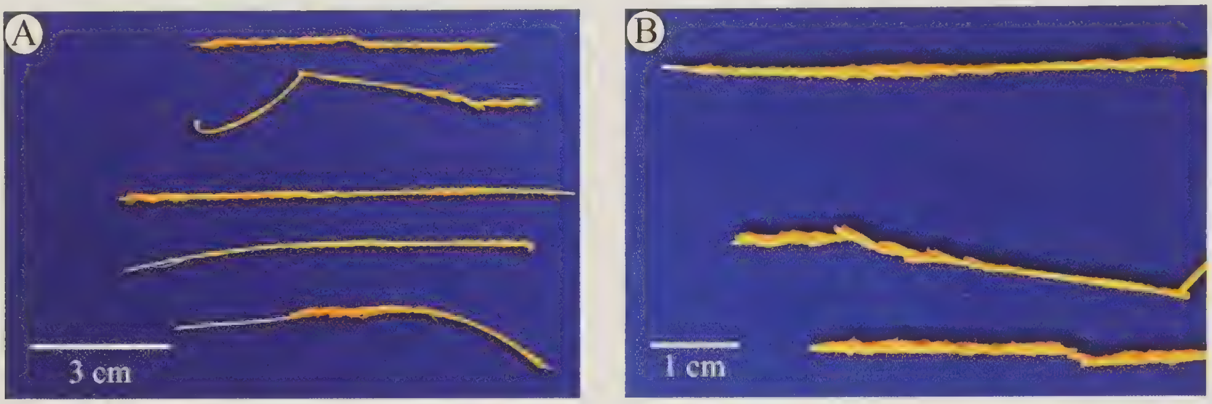
Remarks Known from five specimens (USNM 43778) collected by the U.S. Fisheries Steamer *Albatross* with a beam trawl in 1890 and later identified by E. Deichmann. The specimens were collected at a single location in deep water (1889 m) in the eastern Bering Sea, north of Yunaska Island in the eastern Aleutian Islands.

Distribution Rare. In Alaska – the eastern Bering Sea off the island arc slope of the Aleutian Islands (Fig. 15-20). Elsewhere – largely unknown. The holotype was collected southeast of Honshu, Japan, at *Challenger* station 235, and Nutting's (1909) specimens were collected at two locations (U.S. Fisheries Steamer *Albatross* stations 4541 and 4514) near Monterey Bay, California.

Habitat In Alaska – low-relief, low-current habitat consisting of silt and sand in deep water (1889 m). Elsewhere – the holotype was collected in an area of mud at a depth of 1033 m and the California specimens were collected at depths of 839 and 1114 m.

Photos A) Preserved (in ethanol) mostly whole *V. bromleyi* colonies (USNM 43778) collected north of Yunaska Island (central Aleutian Islands), eastern Bering Sea, at a depth of 1889 m. B) A close-up view of the same specimens in photo A.

18. *Virgularia bromleyi* Kölliker, 1880 (continued)



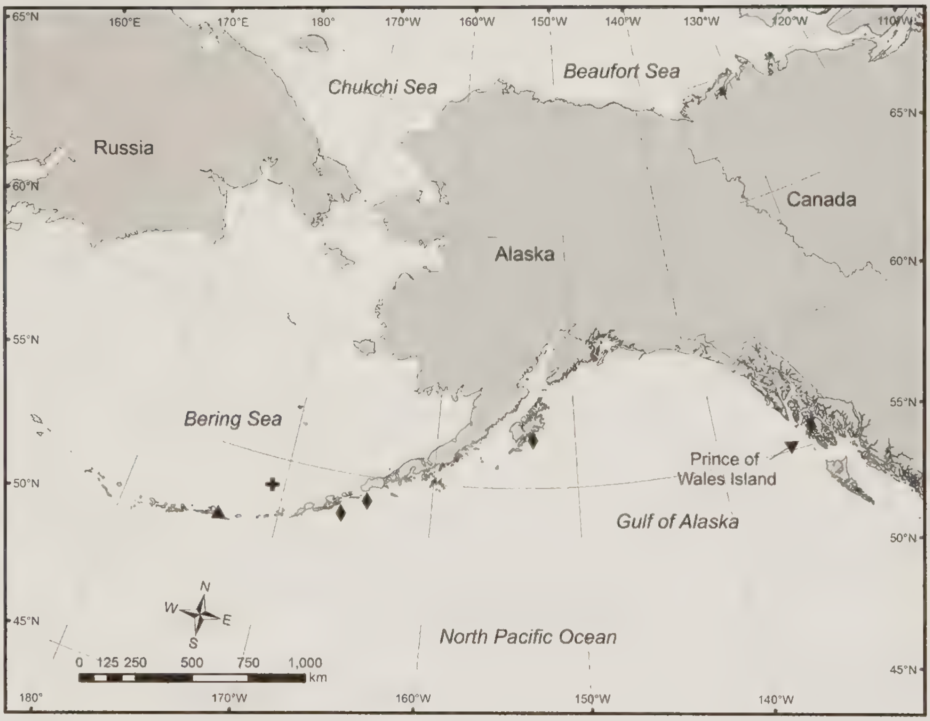

Chukchi Sea
Beaufort Sea
Russia
Canada
Alaska
Bering Sea
Prince of Wales Island
Gulf of Alaska
North Pacific Ocean
N
W
E
S
0 125 250 500 750 1,000 km
65°N
60°N
55°N
50°N
45°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W

Figure 15-20

A map of the North Pacific Ocean showing the distribution of *Virgularia bromleyi* (+), *V.* cf. *bromleyi* (♦), and *V.* cf. *glacialis* (▲) in Alaska waters.

19. *Virgularia* cf. *bromleyi*

Background We synonymize this taxon with *Virgularia bromleyi tuberculata* reported from the Pacific Ocean coast of Honshu, Japan, at 300 m depth (identified by E. Deichmann), and from British Columbia at depths of 20 to 25 m (identified by F. M. Bayer in 1978). These four records are listed in the Smithsonian National Museum of Natural History database. Subspecies *tuberculata* is an invalid designation according to the WoRMS Editorial Board (2022) and *V. tuberculata* Marshall, 1883 is strictly a North Atlantic Ocean species. We suspect that the four specimens from Japan and British Columbia are the same species as four specimens from Alaska identified as *Virgularia* but otherwise with unresolved taxonomy. These specimens appear to have similar morphology to *V. bromleyi* although they are considerably larger and occupy a much shallower bathymetric range.

Description Colonies are whiplike and measure up to 54 cm in length. Colonies are slender but with long branches when extended in situ; width in preserved specimens is up to 15 mm but up to 35 mm when extended in situ. There are up to 66 polyp leaves that are obliquely set or nearly opposite and tapered both proximally and distally. Proximal polyp leaves closest to the sediment interface are rudimentary and without polyps. Fully developed leaves have five polyps that are generally directed laterally. There is a prominent, distinct groove on the ventral side of the axis. The color in life is a creamy or translucent white, almost iridescent; the color in ethanol is a uniform light orange.

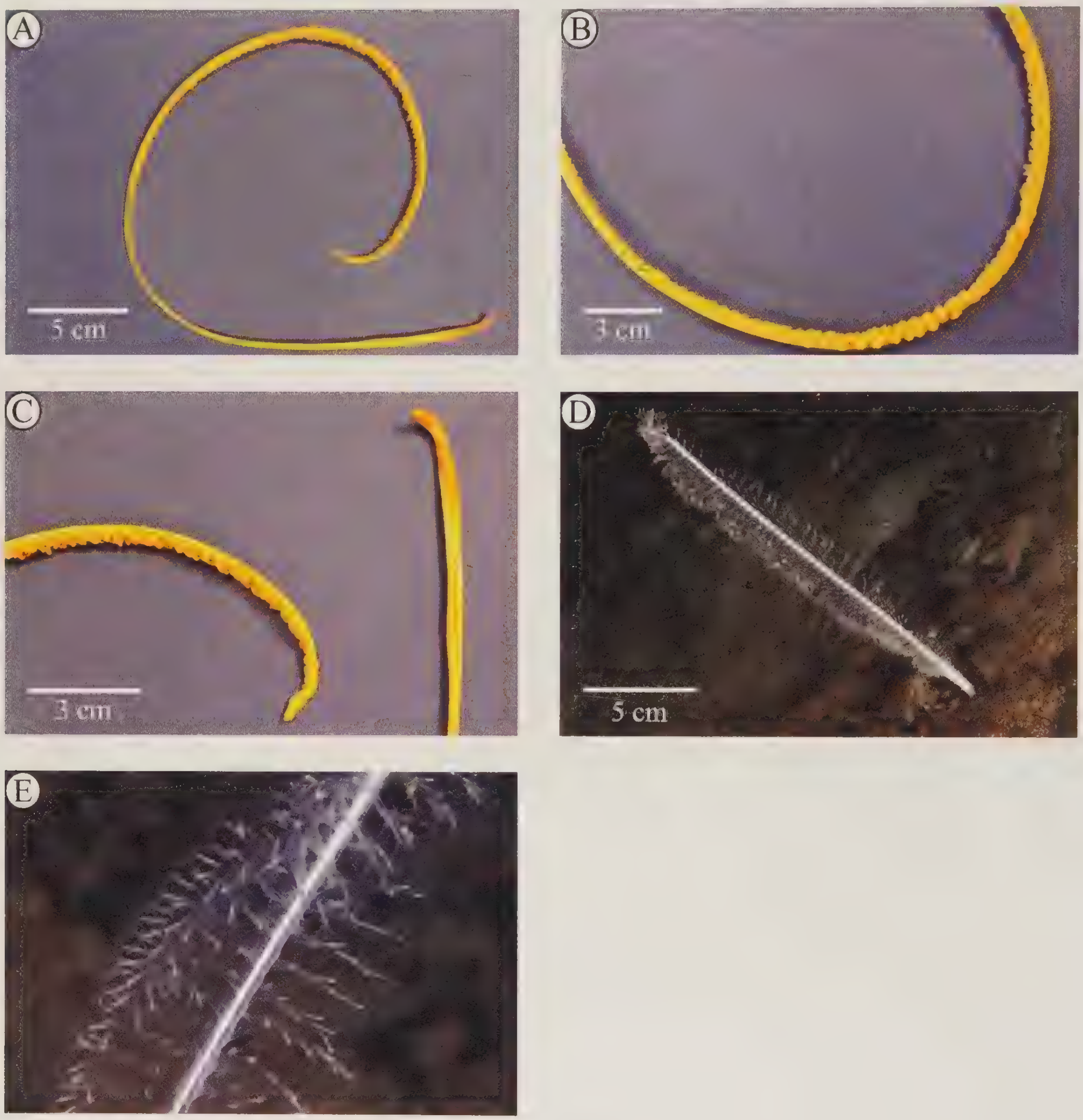
Remarks This taxon includes four shallow-water records from Alaska with unresolved taxonomy. These specimens likely represent an undescribed species but should be carefully re-examined along with other records of *Virgularia* sp. (especially the deeper records) from northern Washington, northern California (13–839 m depth), and southern California (25–1038 m depth), and compared to the records of *V. bromleyi* and *V.* cf. *glacialis* from Alaska.

Distribution Uncommon. In Alaska – reported from the inside waters of Southeast Alaska and through the Gulf of Alaska to the eastern Aleutian Islands (Fig. 15-20). Elsewhere – British Columbia and possibly south to southern California.

Habitat In Alaska – areas of sand, silt, and pebbles at depths between 20 and 472 m. Elsewhere – areas of rock and grey sand, green mud, and soft-brownish shale at depths between 20 and 1038 m.

Photos A) A preserved (in ethanol) whole *Virgularia* cf. *bromleyi* colony (USNM 57267) collected southeast of Sitkalidak Island, western Gulf of Alaska, at a depth of 110 m. B) A close-up view of the rachis and polyp leaves in the same specimen in photo A. C) A close-up view of the distal section of the rachis and the peduncle (right) in the same specimen in photo A. D) A *Virgularia* cf. *bromleyi* colony (USNM 57976) photographed in Indian Arm, Burrard Inlet, British Columbia, at a depth of 25 m. E) A close-up view of the same colony in photo D. F) A *Virgularia* cf. *bromleyi* colony (CAS 163735) photographed in Sea Otter Sound, Southeast Alaska, at a depth of 22 m. Reprinted with permission from Barr and Barr, 1983. G) A *Virgularia* cf. *bromleyi* colony (USNM 57976) photographed in Indian Arm, Burrard Inlet, British Columbia, at a depth of 25 m. Photos D, E, and G are courtesy of Neil McDaniel.

19. *Virgularia* cf. *bromleyi* (continued)


A
5 cm
B
3 cm
C
3 cm
D
5 cm
E

F
5 cm

G
5 cm

20. *Virgularia* cf. *glacialis*

Description The original description of *Virgularia glacialis* by Sars (year unknown) is based on a small fragmented specimen and is rather rudimentary (i.e., it does not even include location data). The subsequent description by Kölliker in 1870 (as *Virgularia steenstrupii*) was based on an almost intact specimen. That specimen is 29.9 cm in length but only 2 mm in width and 18.7 cm (70%) of the specimen contains rather thick polyp leaves (2.2 mm in length) with 10 leaves per 3.2 cm of rachis length. The leaves are nearly triangular or sickle-shaped, attached along their whole length, but with the keel lying such that the dorsal end is much higher than the ventral end.

Polyps number 6–10 with scarcely separated goblets. The back of the keel is completely covered by the leaves and the ventral side is completely exposed except for two notches of the keel. Zooids are numerous with each filling the space between two leaves.

The axis is rather strong and reinforced with short radial fibers. Sclerites are not present, at least in the coenenchyme. The color of the colony is yellow to light brown; the axial skeleton is white.

Remarks Known from six specimens (USNM 1010251) identified by F. M. Bayer and collected from the same location north of Amlia Island, central Aleutian Islands, at a depth of 122 m. Unfortunately the six specimens are severely deteriorated and of no descriptive value. Since these are the only specimen records of the species from the Pacific Ocean and we cannot re-verify their identity due to their poor condition, we list them here as *V.* cf. *glacialis*. They may be a different species of *Virgularia*, perhaps *V.* cf. *bromleyi* or an undescribed species.

Distribution Rare. In Alaska – reported from a single location north of Amlia Island, central Aleutian Islands (Fig. 15-20). Elsewhere – only known from the northwest Atlantic Ocean, principally the fjords of Norway where the type specimen (*V. steenstrupii*) was described from Varangerfjord. *Virgularia steenstrupii* is now synonymized with *V. glacialis* as is another unaccepted species *V. affinis* Koren and Danielssen, 1877 also described from Norwegian waters.

Habitat In Alaska – found at a depth of 122 m. Elsewhere – unknown.

Photos None available.

CHAPTER 16

Class Hydrozoa
Order Anthoathecata
Family Stylasteridae

Corals in the order Anthoathecata, family Stylasteridae are sometimes referred to incorrectly as "hydrocorals" and are actually hydrozoans rather than anthozoans. The more proper common name for stylasterids is "lace corals," as the more general term hydrocoral is polyphyletic, including corals from two different families: Stylasteridae and Milleporidae. Free medusae are not produced in stylasterids like they are in many other hydrozoans, such as the milleporids. Stylasterids occur from the Arctic to the Antarctic at depths of 0 to 2789 m, but are most common at depths between 200 and 1200 m. Currently there are about 316 Recent species, making it the second largest family within the Hydrozoa (Cairns, 2015).

Stylasterids that occur in Alaska waters are colonial but ahermatypic; that is, they do not construct true reefs. Some species of stylasterids, however, are locally abundant and play a major role in constructing important benthic habitats (Stone, 2006, 2014). Twenty-two species (plus one subspecies) of stylasterids from six genera are known from Alaska waters. The current state of taxonomy for the group is very good (Cairns and Lindner, 2011). Nonetheless, all specimens collected in Alaska should be properly preserved for taxonomic examination and zoogeographic study.

Six genera of stylasterids are found in Alaska waters: 1) *Crypthelia* – one species, 2) *Cyclohelia* – one species, 3) *Distichopora* – one species, 4) *Errinopora* – six species, 5) *Stylantheca* – one species, and 6) *Stylaster* – 13 species (including one subspecies). The 10 species in the genus *Errinopora*, six of which occur in Alaska waters, are compared in tabular and dichotomous keys by Cairns and Lindner (2011). The 14 species and subspecies in the genus *Stylaster* known from the Northeast Pacific Ocean, 13 of which occur in Alaska waters, are also compared in a tabular key by Cairns and Lindner (2011).

Conventional terminology used to describe stylasterids, including an illustrated glossary, was published by Cairns (2011a), and a key to all the stylasterid genera can be found in Cairns (2015). Morphology of the calcareous skeleton is used almost exclusively for identification at the species and genus levels (Figs. 16-1, 16-2, 16-3, 16-4, and 16-5). Examination of the colony with a scanning electron microscope is often helpful, but not essential, to identify most Alaska species. Applying dye from a marker to the dry coenosteum will help to determine the coenosteal texture.

The stylasterid colony is polymorphic, meaning that every colony is composed of three types of polyps that are connected within the branch by a reticulate canal system: the gastrozooid (the feeding polyp), the dactylozooid (the defensive polyp), and the gonophore (the reproductive polyp). Each of these polyps has a corresponding calcare-

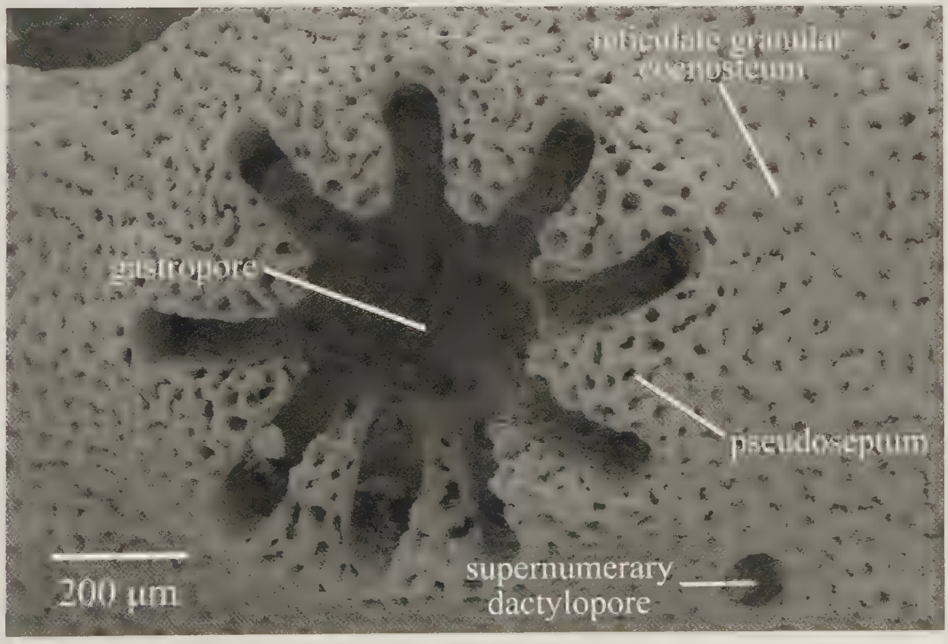


Figure 16-1

A photograph of the cyclosystem (center) of a *Stylaster brochi* colony showing the gastropore and surrounding structures.

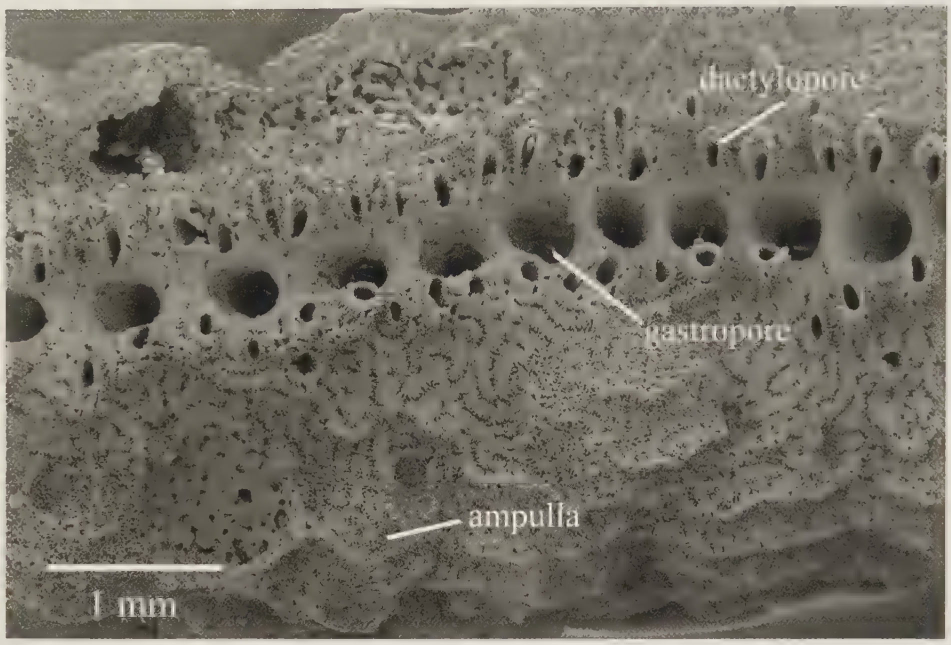

dactylopore
gastropore
ampulla
1 mm

Figure 16-2

A photograph of the distichoporine pore row (center) of a female *Distichopora borealis* colony showing the gastropore row, accompanying dactylopore rows, and ampullae.

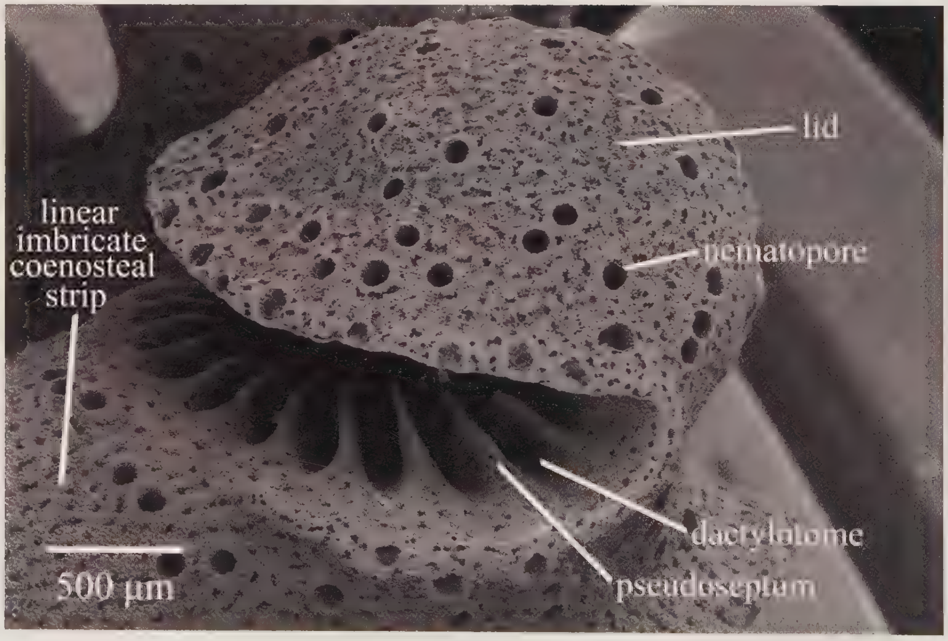

lid
linear imbricate coenosteal strip
nematopore
dactylotome
pseudoseptum
500 µm

Figure 16-3

A close-up view of the fixed lid covering the cyclosystem of a *Crypthelia trophostega* colony and the associated structures.

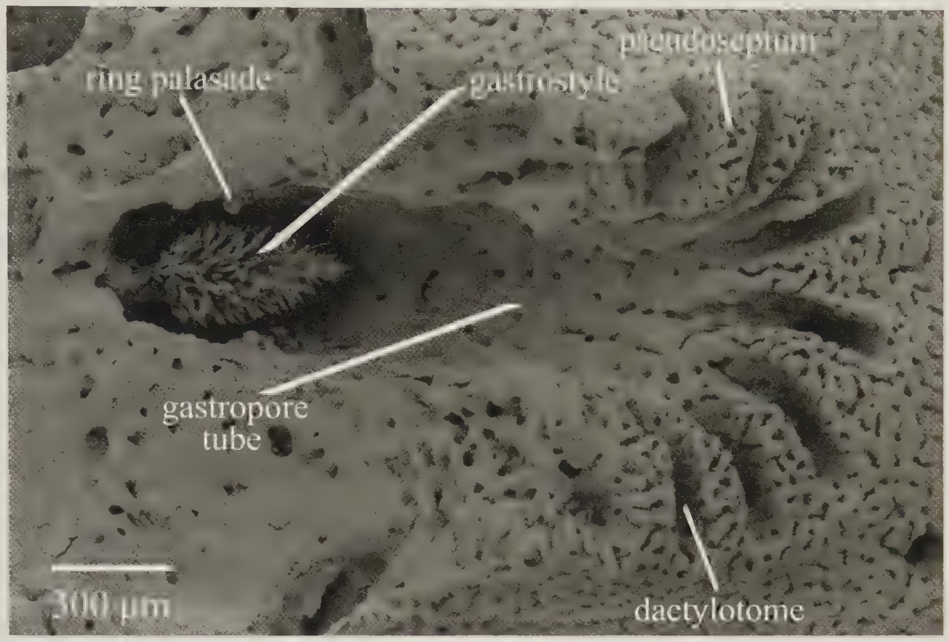

ring palasade
gastrostyle
pseudoseptum
gastropore tube
300 µm
dactylotome

Figure 16-4

A close-up view of the gastropore tube of a *Stylaster brochi* colony and the associated structures.

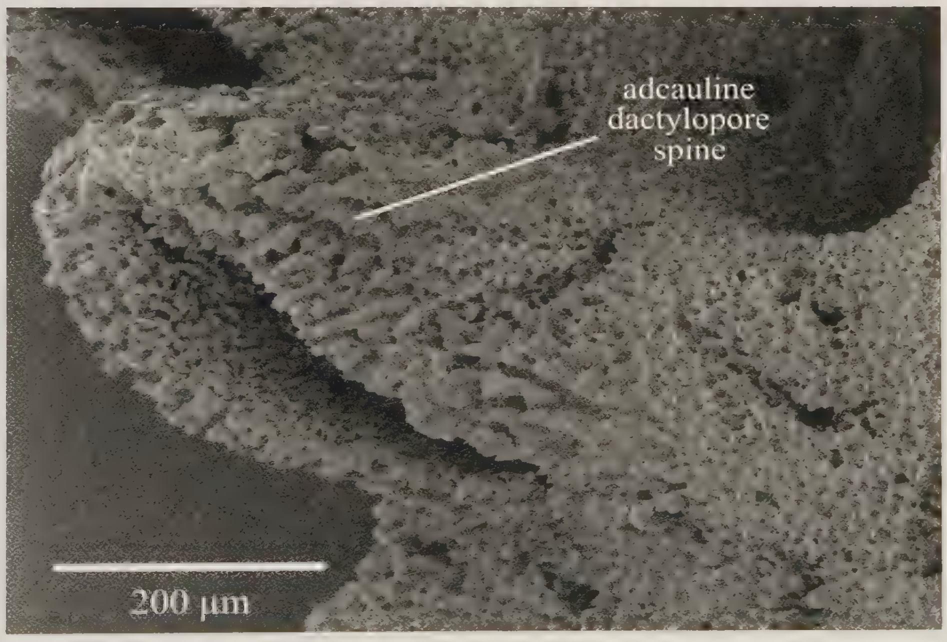

adcauline dactylopore spine
200 µm

Figure 16-5

A close-up view of a *Distichopora borealis* colony showing an adcauline dactylopore spine.

ous structure associated with it: the gastrozooid has a gastropore and gastropore tube, the dactylozooid has a dactylopore and dactylopore spine, and the gonophore has an ampulla. In some genera, several dactylopores encircle a single gastropore in a structure called a cyclosystem. Each gastrozooid has a mouth encircled by a ring of tentacles, and each dactylozooid consists of one functional tentacle. Most stylasterids, including all from Alaska, are gonochoric, meaning that each colony is either male or female, which can usually be determined by the size and shape of their ampullae.

The reproductive ecology of seven species from the Aleutian Islands was studied and all were brooders, with the majority of gonophores containing mature embryos or planulae (Brooke and Stone, 2007). The developmental stage of gametes within individual colonies was not highly synchronized; females contained eggs as well as planulae, and males exhibited a range of gamete development. These reproductive traits indicate that hydrocorals have limited potential to recolonize disturbed areas in the Aleutian Islands (Brooke and Stone, 2007).

Stylasterids are found in only three regions of Alaska (eastern Gulf of Alaska, western Gulf of Alaska, and the Aleutian Islands) and are noticeably absent from the Gulf of Alaska Seamount Province and the Arctic (Fig. 16-6). They are also unknown from the Bering Sea continental shelf; however, several species (*Crypthelia trophostega* Fisher, 1938; *Cyclohelia lamellata* Cairns, 1991; and *Distichopora borealis* Fisher, 1938) occur on Petrel and Bowers Banks that extend northward from the central Aleutian Islands into the Bering Sea. The Aleutian Islands are far and away the hotspot of diversity in Alaska waters; 15 of 23 taxa appear to be endemic to the region and half of the remaining eight taxa occur there. The records for most genera represent the northernmost in the world. They are eurybathic fauna in Alaska, occupying depths between 11 and 2124 m. All taxa are firmly attached and typically grow on bedrock, boulders, cobbles, pebbles, and occasionally on siltstone and hexactinellid sponge skeleton.

Most taxa are quite small, generally less than 10 cm in height and width, but a few species—e.g., *Stylaster campylecus* (Fisher, 1938) and *Stylaster alaskanus* Fisher, 1938—attain sizes up to 60 cm in height and width. Most taxa are found either in low- or high-density patches; these patches may provide important refuge and foraging habitat for juvenile fish and crabs (Stone and Shotwell, 2007). They are a fairly common bycatch item in fisheries and stock assessment surveys but are extremely fragile, often fragmented, and seldom retained for formal identification and reference collections.

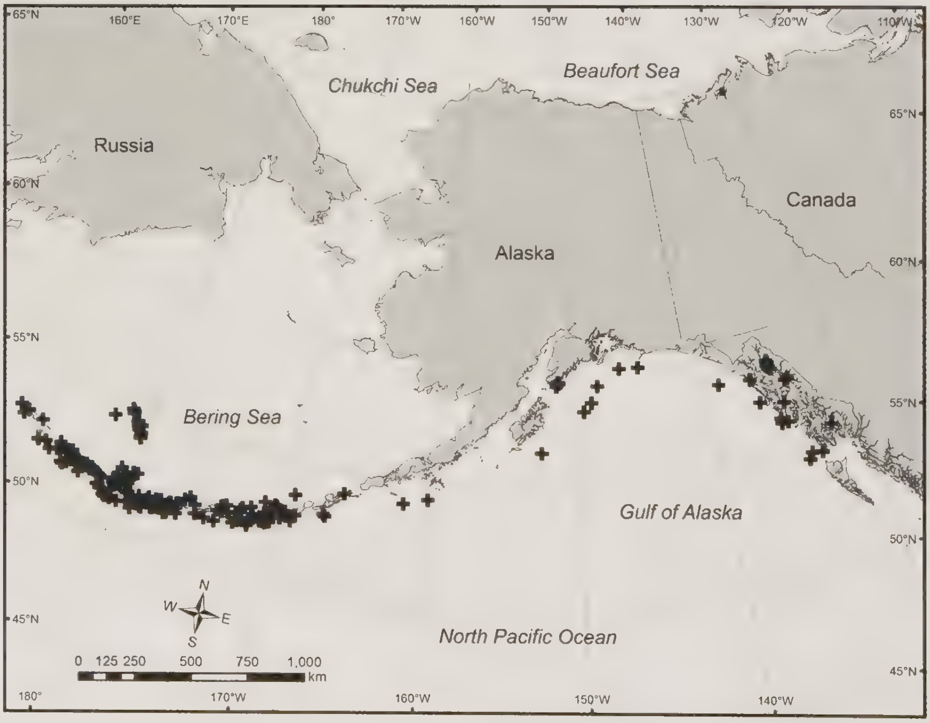


Figure 16-6

A map of the North Pacific Ocean showing the distribution of corals in the family Stylasteridae (+) in Alaska waters.

1. *Crypthelia trophostega* Fisher, 1938

Description (Adapted from Cairns and Lindner, 2011) Colony branching is usually uniplanar, but occasionally multiplanar or bushy, and dichotomous. Branch anastomosis is common. The largest colony known is about 20 cm in height and width. The coenosteum is linear-imbricate in texture. Nematopores are common and occur on the coenosteum, cyclosystem lid, and pseudosepta. The coenosteum and tissue are creamy white to white.

The gastropores and dactylopores are arranged in discrete cyclosystems that occur unilinearly and unifacially or bifacially on branches. The cyclosystems are 2.2–2.6 mm in diameter, each having 13–23 dactylopores, but averaging about 19. Every cyclosystem is covered with a large horizontal fixed lid that covers most of the gastropore (Fig. 16-3). The gastropore tube is double-chambered.

The female ampullae are massive hemispherical swellings, one or two of which occur on the cyclosystem lid, and their efferent pores open beneath the lid. The male ampullae are smaller, up to 11 also occur on the lid, and their efferent pores also open beneath the lid.

Remarks *Crypthelia* is a species-rich genus (46 species) worldwide; however, only a single species is known from Alaska waters. They are easily diagnosed by having a cyclosystem lid. The reproductive ecology of this species has been studied from colonies collected in the Aleutian Islands (Brooke and Stone, 2007). The coenosteum is composed mostly of aragonite with small amounts of low-magnesium calcite (Cairns and Macintyre, 1992; senior author and S. D. Cairns, unpubl. data).

Distribution Common. In Alaska – endemic to the Aleutian Islands (Amukta Pass to southeast of Agattu Island) including Bowers Bank (Fig. 16-7). There is a single record (USNM 76781) collected by a fishing vessel near the Pribilof Islands, eastern Bering Sea, at a depth of 550 m. We discount this record as one that was almost certainly translocated by fishing gear. Elsewhere – not reported.

Habitat Typically found singly but occasionally in small patches, on hard rock including cobbles and large

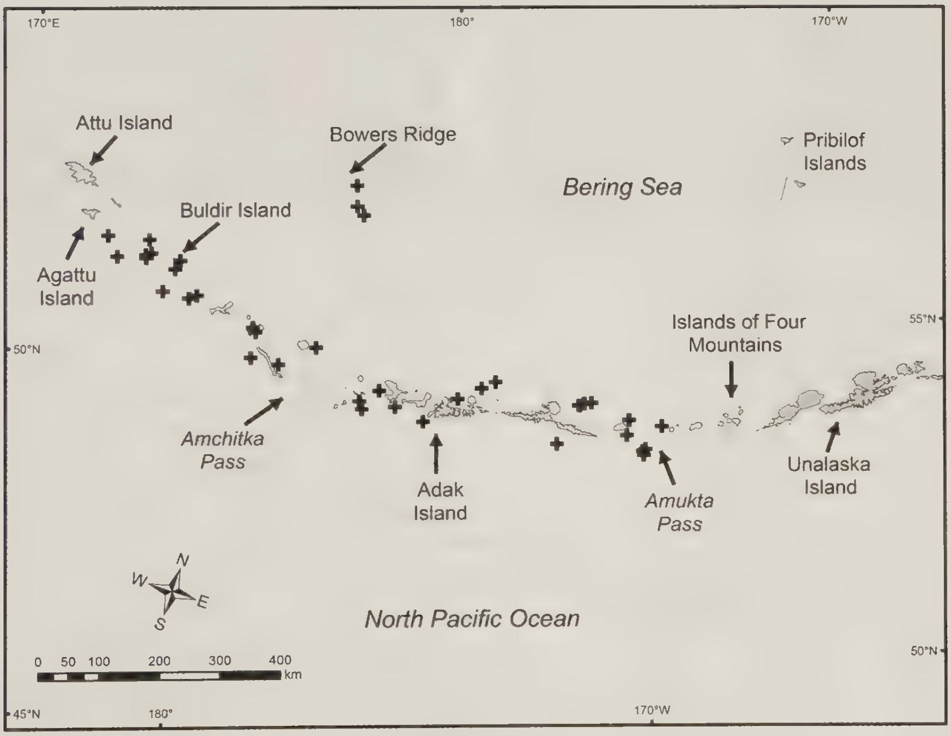
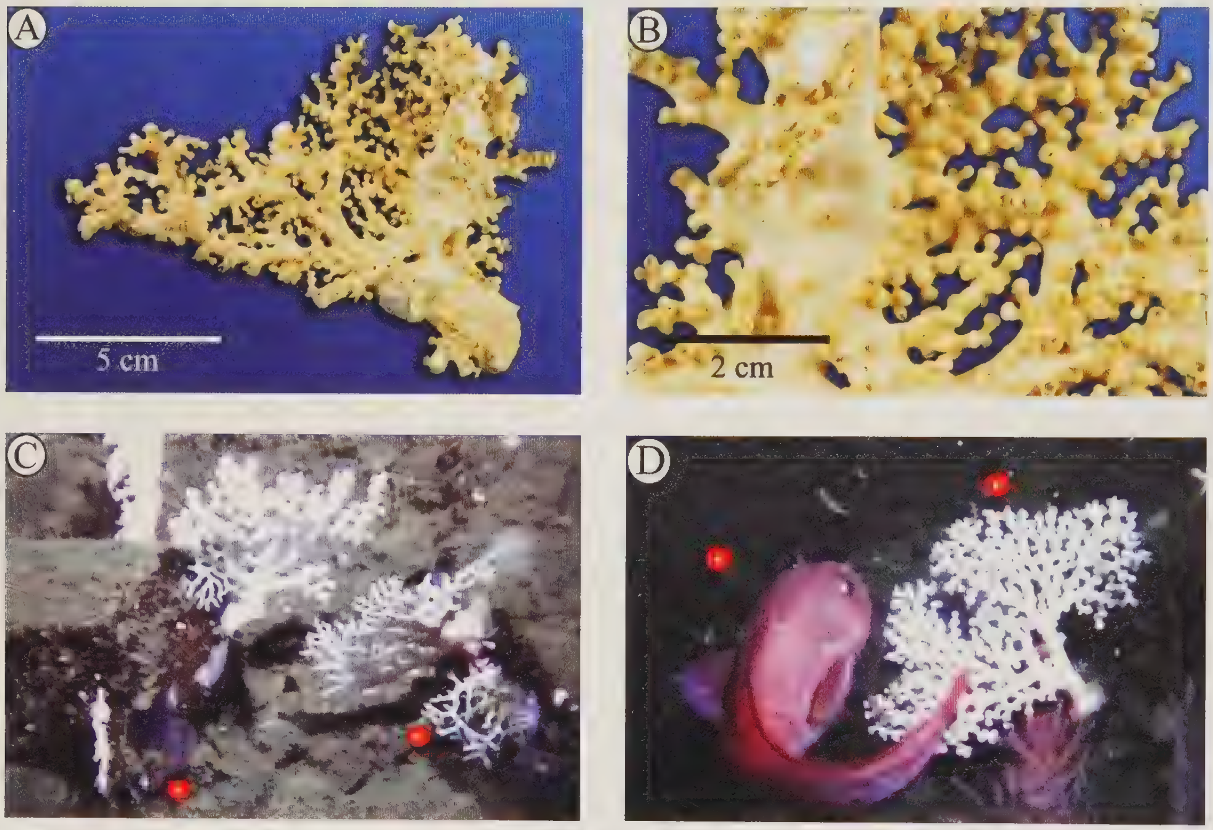

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Agattu Island
55°N
50°N
Islands of Four Mountains
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-7

A map of the Aleutian Islands showing the distribution of *Crypthelia trophostega* (+) in Alaska waters.

pebbles, in areas of moderate current, and at depths between 138 and 1913 m.

Photos A) Most of a whole dried C. *trophostega* colony (USNM 1482073) collected east of Semisopochnoi Island, in the central Aleutian Islands, at a depth of 457 m. B) A close-up view of the same specimen in photo A. C) A C. *trophostega* colony photographed in Adak Canyon, central Aleutian Islands, at a depth of 1335 m. D) A C. *trophostega* colony photographed northwest of Tanaga Island, central Aleutian Islands, at a depth of 1247 m. An unknown liparid (snailfish) takes refuge near the coral. The distance between the red laser marks in photos C and D is 10 cm.



2. *Cyclohelia lamellata* Cairns, 1991

Description (Adapted from Cairns, 1991 and Cairns and Lindner, 2011) Colonies are firmly attached by a robust cylindrical stem that is up to 2.5 cm in diameter and bifurcates into two lamellae or plates, each of which increases its surface area by folding and undulating its surface into a complex three-dimensional structure. Some colonies are coarsely digitiform. Large colonies are up to 8 cm in height and 10 cm in width. The coenosteum is reticulate-granular in texture; nematopores are absent. The color of the coenosteum is typically reddish-orange and rarely yellow in lamellate forms, but is typically pink in digitate forms.

The gastro- and dactylopores are abundant and occur uniformly but without coordination on all corallum faces. The gastropores are circular and flush with coenosteum; the gastrostyles are elongate and needle-shaped. The dactylopore spines are elliptical in shape and the lateral edges are higher than the edges at the vertices.

The female ampullae are primarily internal and up to 1.1 mm in internal diameter. The male ampullae are also internal but smaller, only up to about 0.6 mm in internal diameter, and communicate to the surface via a narrow efferent duct.

Remarks *Cyclohelia* is a monotypic genus closely related to *Distichopora* but differs in having non-linear gastro- and dactylopores and internal ampullae. The reproductive ecology of this species has been studied from colonies collected in the Aleutian Islands (Brooke and Stone, 2007). The coenosteum is composed entirely of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – endemic to the Aleutian Islands (Islands of Four Mountains to west of Buldir Island) including Petrel Bank (Fig. 16-8). There is a single record (USNM 85007) collected by a fishing vessel near the Pribilof Islands, eastern Bering Sea, at a depth of 550 m. We discount this record as one that was almost certainly translocated by fishing gear. Elsewhere – not reported.

Habitat Typically found singly but occasionally in small patches, on hard rock including bedrock and cobbles, in areas of high to moderate current, and at depths between 27 and 405 m (video observations to 691 m; Stone, 2014).

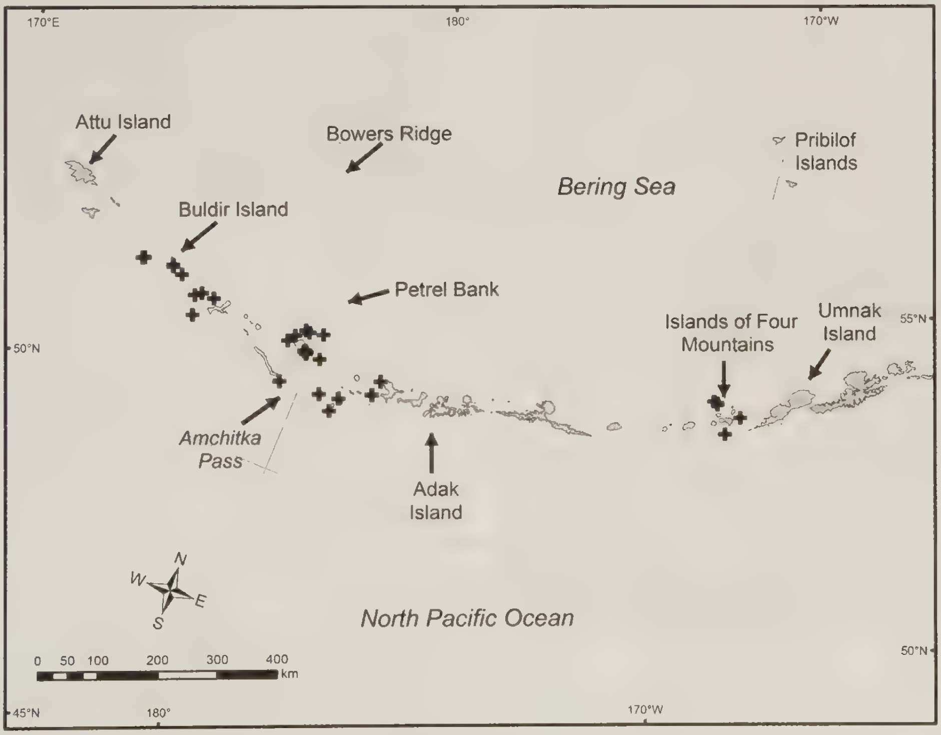
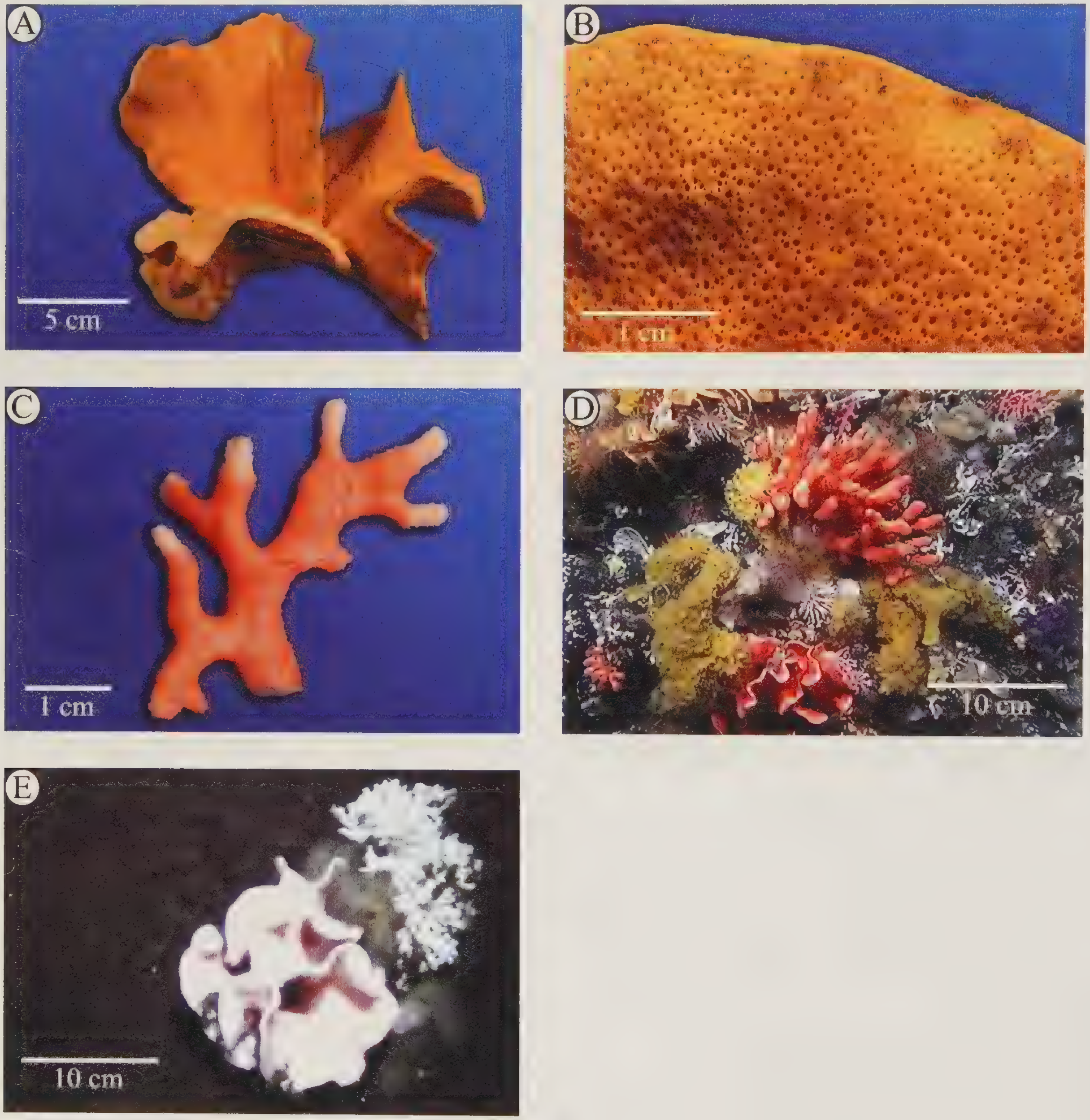


Figure 16-8

A map of the Aleutian Islands showing the distribution of *Cyclohelia lamellata* (+) in Alaska waters.

Photos A) Most of a dried whole C. *lamellata* colony (USNM 1482043) in the common lamellar form. This specimen was collected northwest of Kiska Island, western Aleutian Islands, at a depth of 366 m. B) A close-up view of the same specimen in photo A. C) A dried branch of a C. *lamellata* colony in the less common digitate form (USNM 1482046) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 115 m. D) A lamellar form of C. *lamellata* (at the bottom-center of the image) photographed northwest of Tanaga Island, central Aleutian Islands, at a depth of 170 m. E) A lamellar form of C. *lamellata* (center) photographed in the central Aleutian Islands at a depth of 498 m.



3. *Distichopora borealis* Fisher, 1938

Description (Adapted from Cairns and Lindner, 2011) Colonies are usually uniplanar in branching but occasionally multiplanar or arborescent. Branching is irregularly dichotomous and sometimes anastomotic; branch tips are rounded to blunt. Large colonies are up to 11 cm in height and 20 cm in width, with a basal branch diameter up to 3 cm. The coenosteum is reticulate-granular in texture and often longitudinally ridged; nematopores are absent. The coenosteum is white to light orange, and the latter color morph has a white core.

The gastro- and dactylopores are arranged in pore rows; the gastropores are unilinearly arranged on branch edges and flanked on either side by a row of dactylopore spines. The gastropores are circular, 12–16 per centimeter; the gastrostyles are needle-shaped. The dactylopore spines are U-shaped and occur 18–40 per centimeter; dactylostyles are absent.

The female ampullae are prominent superficial mounds up to 1.5 mm in diameter, each having a lateral efferent pore. The male ampullae are primarily internal, irregular in shape, and rarely more than 0.4 mm in diameter.

Remarks This species (and genus) is easily distinguished from all other stylasterids in Alaska waters by the unique coordination of its gastro- and dactylopores in pore rows. Otherwise, *Distichopora* is a widely distributed genus at depths of 0 to 1361 m, containing 27 described species (Cairns, 2015).

The coenosteum is composed principally (92–99%) of high-magnesium calcite (9.0–9.7 mol% $MgCO_3$) with small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Common. In Alaska – this species has a highly disjunct distribution. It is known mostly from the Aleutian Islands (southwest of Umnak Island to west of Attu Island) including Petrel and Bowers Banks and also from Shutter Ridge in the eastern Gulf of Alaska (Fig. 16-9). Only a single specimen has been collected in the eastern Gulf of Alaska, but video observations (Stone et al., 2015a) indicate that the species is relatively common there at depths between 137 and 244 m. Elsewhere – not reported.

Habitat Typically found singly but occasionally in small patches, on hard rock including bedrock, cobbles,

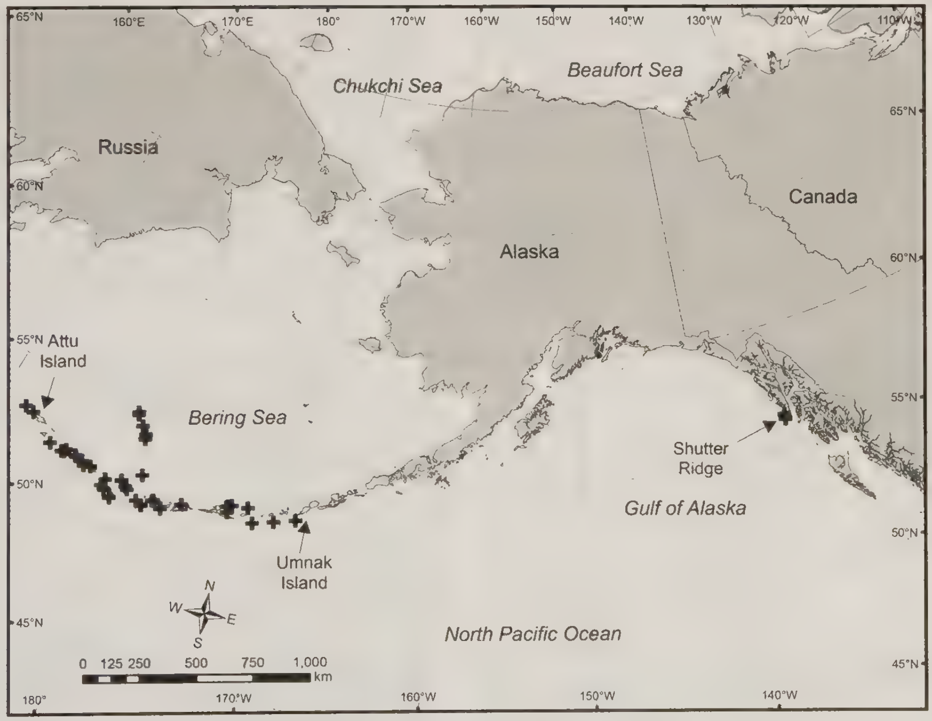
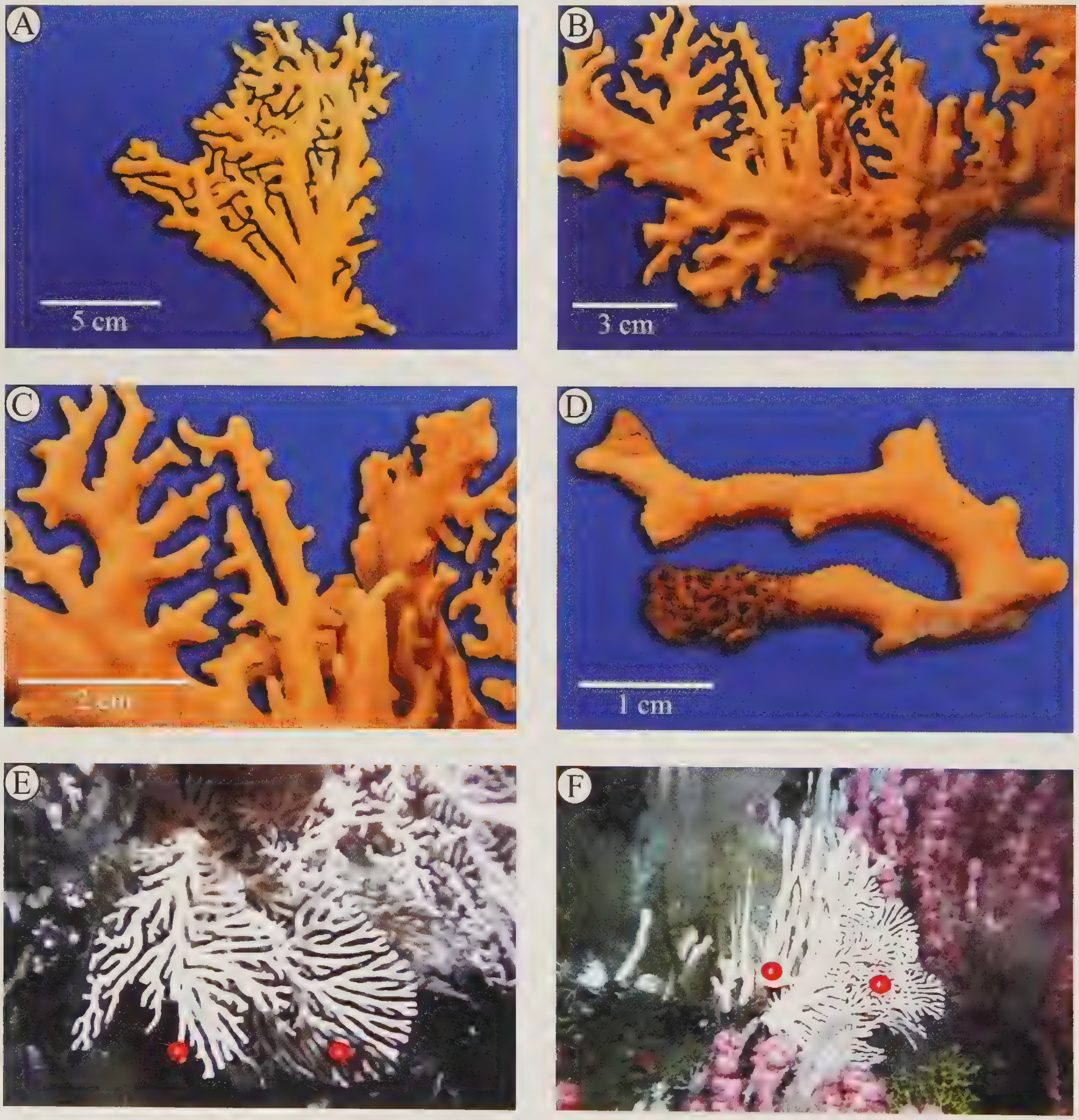

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
Attu Island
Bering Sea
55°N
Shutter Ridge
50°N
Gulf of Alaska
50°N
Umnak Island
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000 km
45°N
180°
170°W
160°W
150°W
140°W

Figure 16-9

A map of the North Pacific Ocean showing the distribution of *Distichopora borealis* (+) in Alaska waters.

and pebbles, in areas of moderate current, and at depths between 137 and 1361 m. The latter depth is the greatest for any species in the genus. In the eastern Gulf of Alaska this species forms patches with *Stylaster parageus parageus* (Fisher, 1938) where it constitutes about 10% of the total number of hydrocorals present.

Photos A) Most of a whole dried *D. borealis* colony (USNM 1482063) collected in the western Aleutian Islands at a depth of 292 m. B) Most of a whole dried *D. borealis* colony (USNM 1482065) collected in the western Aleutian Islands at a depth of 256 m. C) A close-up view of the same specimen in photo B. D) Dried branches of a *D. borealis* colony (USNM 1482068) collected in the central Aleutian Islands at a depth of 1266 m. The tip of the lower branch is overgrown by a demosponge. E) Several *D. borealis* colonies in situ in the central Aleutian Islands at a depth of 681 m. F) A *D. borealis* colony in situ in the central Aleutian Islands at a depth of 720 m. The distance between the red lasers marks in photos E and F is 10 cm.



4. *Errinopora dichotoma* Lindner and Cairns, 2011

Description (Adapted from Cairns and Lindner, 2011) Colonies are robust, with sparse, dichotomous, three-dimensional branching. Colonies are up to 11.5 cm in height with basal branch diameters up to 2 cm; the branch tips are blunt. The coenosteal texture is reticulate-spinose. The coenosteum is light orange in color and the branch core is white.

The gastropores are circular, 0.3–0.5 mm in diameter, and arranged randomly or in rows; the gastrostyles are lanceolate. Smaller gastropores (0.22–0.30 mm in diameter) are also present. The dactylopore spines are quite variable in orientation, sometimes aligned in longitudinal or transverse rows flanking the gastropores, or isolated in random orientation. The dactylopore spines are thick-walled, up to 1.1 mm in height, and often laterally fused to one another. The dactylostyles are robust.

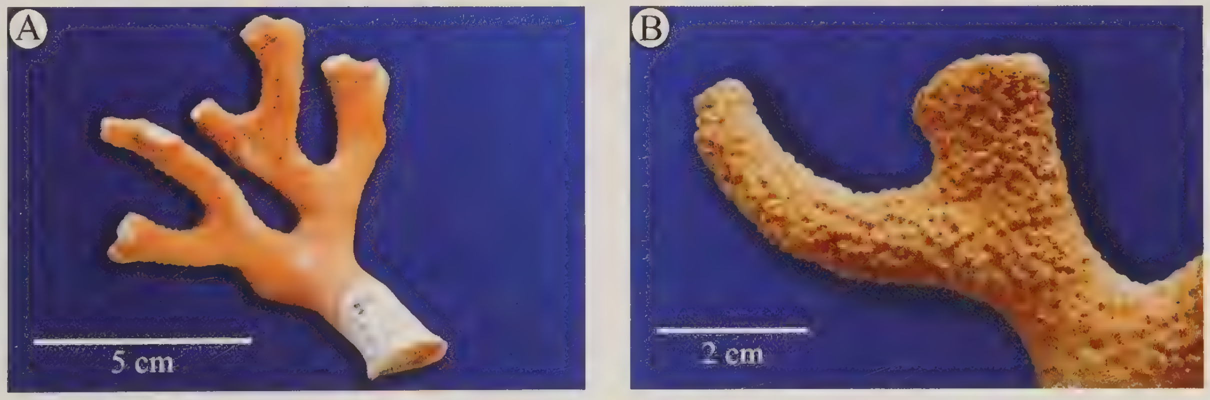
The female ampullae are known only from spent depressions (1.0–1.1 mm in diameter) in the coenosteum. The male ampullae are small (0.5–0.6 mm in diameter), porous superficial hemispheres.

Remarks The coenosteum is composed principally (98.7%) of high-magnesium calcite (10.9 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Rare (known from only four specimens). In Alaska – endemic to the eastern Aleutian Islands from the Islands of Four Mountains to near Seguam Island (Fig. 16-10). Elsewhere – not reported.

Habitat Largely unknown but attaches to hard rock in areas of moderate to high current and at depths between 175 and 405 m.

Photos A) Most of a whole dried *E. dichotoma* colony (USNM 1123507; paratype) collected near the Islands of Four Mountains, eastern Aleutian Islands, at a depth of 405 m. B) A close-up view of a dried *E. dichotoma* specimen (USNM 1137600; paratype) collected near the Islands of Four Mountains at a depth of 176 m.



4. *Errinopora dichotoma* Lindner and Cairns, 2011 (continued)

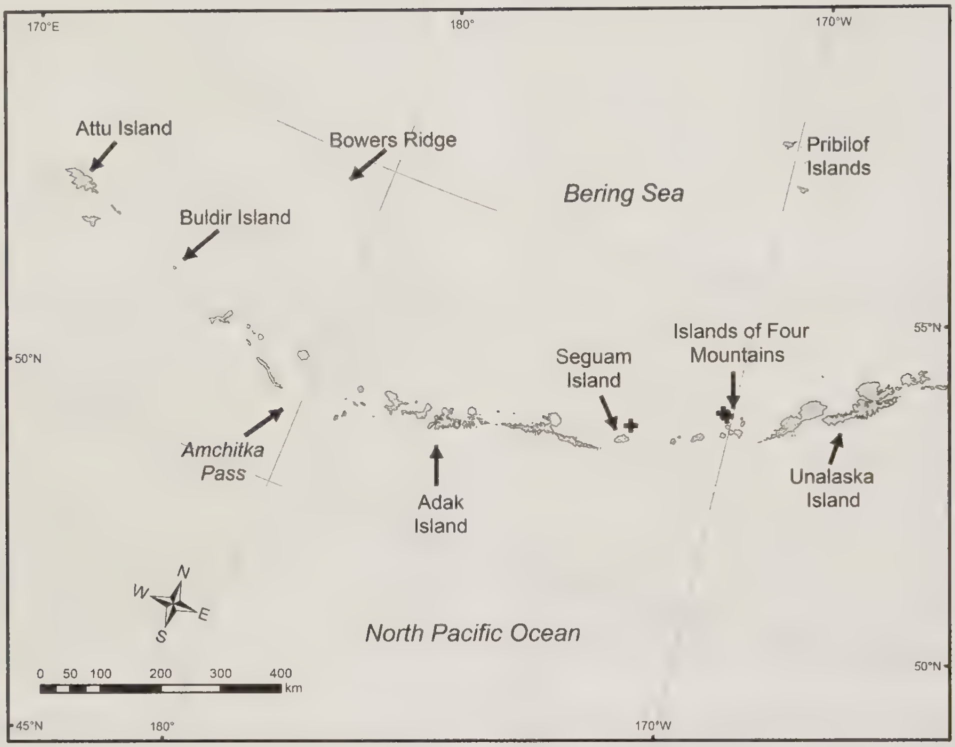

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
Seguam Island
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-10

A map of the Aleutian Islands showing the distribution of *Errinopora dichotoma* (+) in Alaska waters.

5. *Errinopora disticha* Lindner and Cairns, 2011

Description (Adapted from Cairns and Lindner, 2011) Colonies are robust with dichotomous branching that forms uniplanar to multiplanar coralla up to 13.5 cm in height. Branches are circular in cross section, but most often strongly compressed. The coenosteal texture is reticulate-spinose. The coenosteum is light orange in color with a white branch core. Parasitic spionid polychaete tubes are found in branch axes of some colonies.

The gastropores are circular in shape, 0.3–0.7 mm in diameter, and often arranged unilinearly in a shallow sulcus similar to *Distichopora*; the gastrostyles are lanceolate. A smaller class of gastropores measures only 0.2–0.3 mm in diameter. The dactylopore spines are arranged in long meandering rows flanking both sides of a gastropore row (thus bilaterally arranged) and their lateral edges are often fused. The dactylopore spines are thick-walled and short (only 0.5–0.9 mm in length); the dactylostyles are robust.

The female ampullae are superficial mounds, 1.3–1.5 mm in diameter, and sometimes with a ridged surface. The male ampullae are also superficial blisters, 0.4–0.6 mm in diameter, and often occur in dense concentrations.

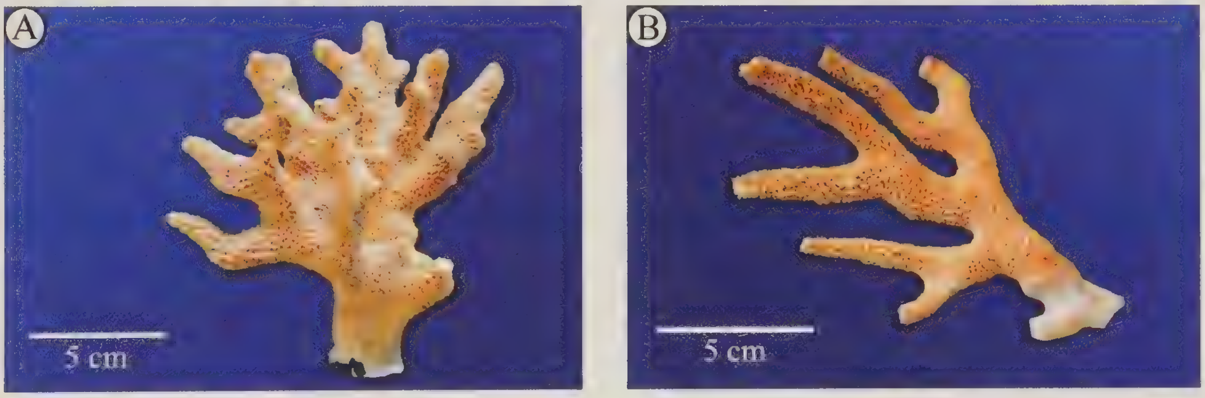
Remarks *Errinopora disticha* is the only species of *Errinopora* in Alaska that has a distichoporine arrangement of its gastro- and dactylopores (Fig. 16-2).

The coenosteum is composed principally (92%) of high-magnesium calcite (10.4–11.6 mol% $MgCO_3$) with small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Rare. In Alaska – endemic to the Aleutian Islands from the Islands of Four Mountains to northwest of Semisopochnoi Island (Fig. 16-11). Elsewhere – not reported.

Habitat Largely unknown but attaches to hard rock in areas of moderate to high current and at depths between 176 and 536 m.

Photos A) The dried *E. disticha* holotype (USNM 1123524; most of a whole colony) collected near Semisopochnoi Island, western Aleutian Islands, at a depth of 530 m. B) Most of a whole dried *E. disticha* colony (USNM 1123523; paratype) collected near Semisopochnoi Island at a depth of 475 m.



5. *Errinopora disticha* Lindner and Cairns, 2011 (continued)

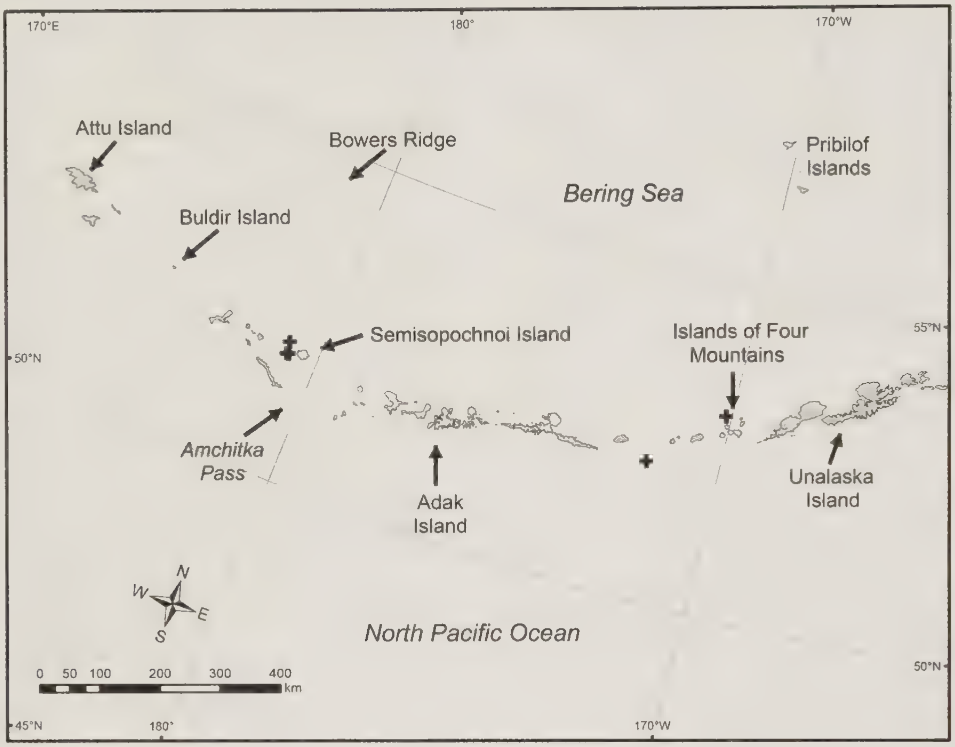

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Semisopochnoi Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-11

A map of the Aleutian Islands showing the distribution of *Errinopora disticha* (+) in Alaska waters.

6. *Errinopora fisheri* Lindner and Cairns, 2011

Description (Adapted from Cairns and Lindner, 2011) Colonies branch in a uniplanar fashion, with fine irregular dichotomous branching; the branch tips are slender. Colonies are up to 9 cm in height and 6.5 cm in width. The coenosteal texture is reticulate-granular and the coenosteum is light orange.

The gastropores are circular, 0.3–0.5 mm in diameter, and arranged uniformly on the branch surfaces; the gastrostyles are squat. The dactylopore spines are arranged in abcauline crescents below a gastropore or even encircling a gastropore, similar to the way they are in *Stylaster*. The dactylopore spines are up to 1.5 mm in height and laterally fused; the dactylotomes are elliptical in shape (not slit-shaped); and the dactylostyles are robust.

The female ampullae are superficial hemispheres (1.0–1.2 mm in diameter); efferent pores appear to be lacking. Male ampullae are unknown.

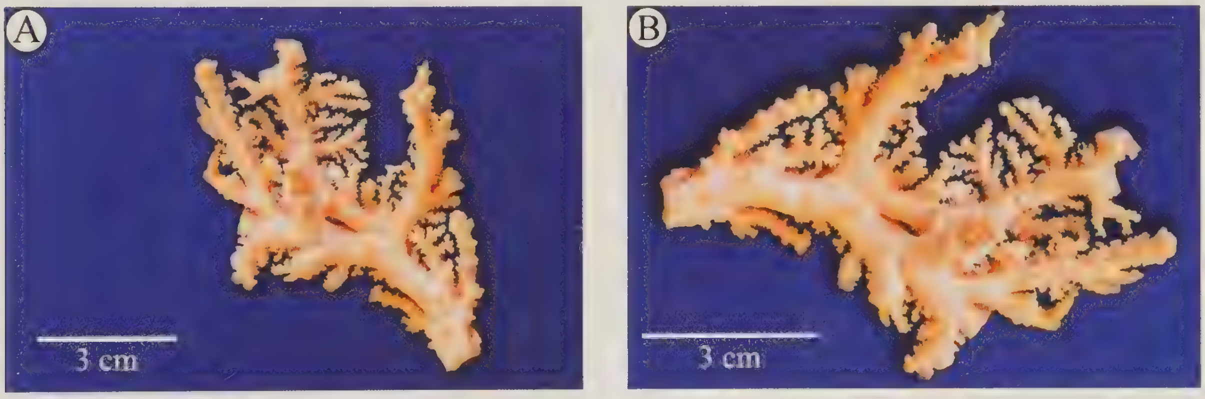
Remarks *Errinopora fisheri* is unique among the Alaska species in having gastro- and dactylopores arranged in pseudocyclosystems.

The coenosteum is composed principally (95%) of high-magnesium calcite (10.6 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Extremely rare (known only from the two type specimens). In Alaska – endemic to the western Aleutian Islands (west of Attu Island; Fig. 16-12). Elsewhere – not reported.

Habitat Largely unknown but attaches to hard rock in areas of moderate to high current and at depths between 455 and 458 m.

Photos A) The dried *E. fisheri* holotype (USNM 1123526; whole colony) collected near Attu Island, western Aleutian Islands, at a depth of 455 m. B) A close-up view of the same specimen in photo A.



6. *Errinopora fisheri* Lindner and Cairns, 2011 (continued)

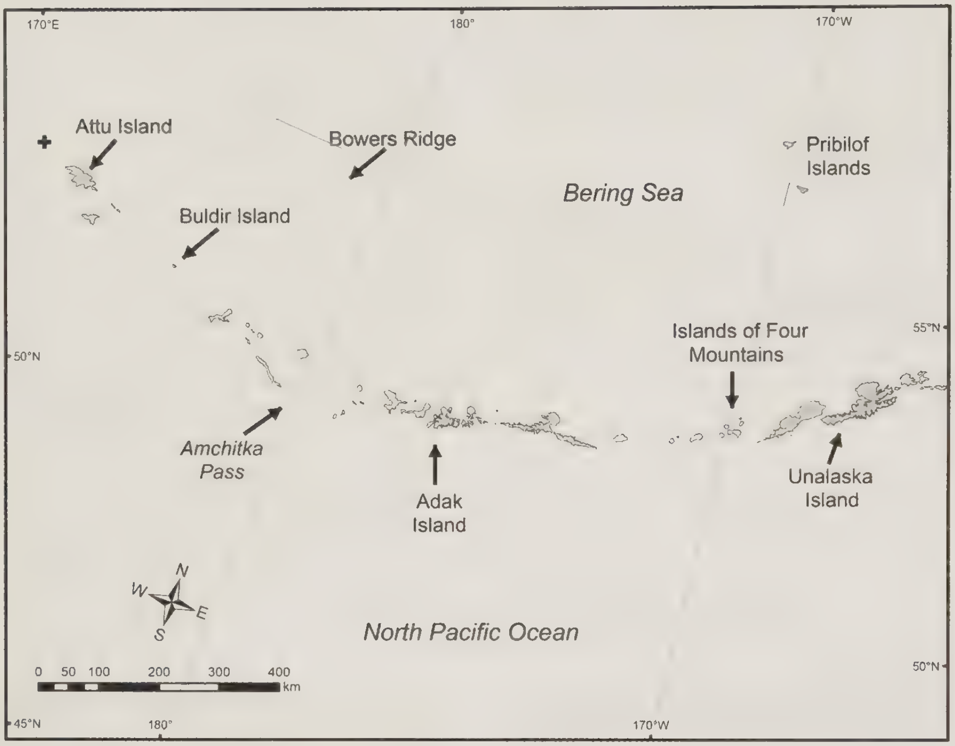

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-12

A map of the Aleutian Islands showing the distribution of *Errinopora fisheri* (+) in Alaska waters.

7. *Errinopora nanneca* Fisher, 1938

Description (Adapted from Cairns and Lindner, 2011) Colonies are quite variable in shape; branching is usually uniplanar and irregularly dichotomous but occasionally multiplanar and multilobate. Parasitic spionid polychaetes often form tubes along the branch axes. Colonies are large, up to 21 cm in height and width. The coenosteal texture is reticulate-spinose. The coenosteum is typically orange but occasionally pink (in deeper water).

The gastropores are circular, flush with the coenosteum, and 0.15–0.44 mm in diameter; the gastrostyles are lanceolate. The dactylopore spines are isolated or arranged in transverse to oblique rows with the dactylotomes facing upward (abcauline) and their lateral edges fusing. Dactylopore spines are relatively small (only 0.4 mm in height); the dactylostyles are robust.

The female ampullae are large superficial hemispheres (1.1–1.8 mm in diameter) and each has a lateral efferent pore. The male ampullae are smaller mounds (0.4–0.7 mm in diameter) and are often clustered. Both types of ampullae are porous.

Remarks The reproductive ecology of this species has been studied from colonies collected in the Aleutian Islands (Brooke and Stone, 2007). The skeleton (coenosteum) is composed principally (97%) of high-magnesium calcite (9.9–10.9 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (Cairns and Macintyre, 1992; senior author and S. D. Cairns, unpubl. data).

Distribution Common and locally abundant. In Alaska – endemic to the Aleutian Islands (Islands of Four Mountains to Tahoma Reef southwest of Buldir Island), including Petrel Bank (Fig. 16-13). Elsewhere – not reported.

Habitat Found singly but occasionally in small patches on hard rock, including bedrock, cobbles, and pebbles, in areas of moderate current, and at depths between 22 and 594 m.

Photos A) A dried whole *E. nanneca* colony (USNM 1481973) collected near Bobrof Island, central Aleutian Islands, at a depth of 27 m. B) A dried whole *E. nanneca* colony (USNM 1481966) collected near Semisopochnoi Island, central Aleutian Islands, at a depth of

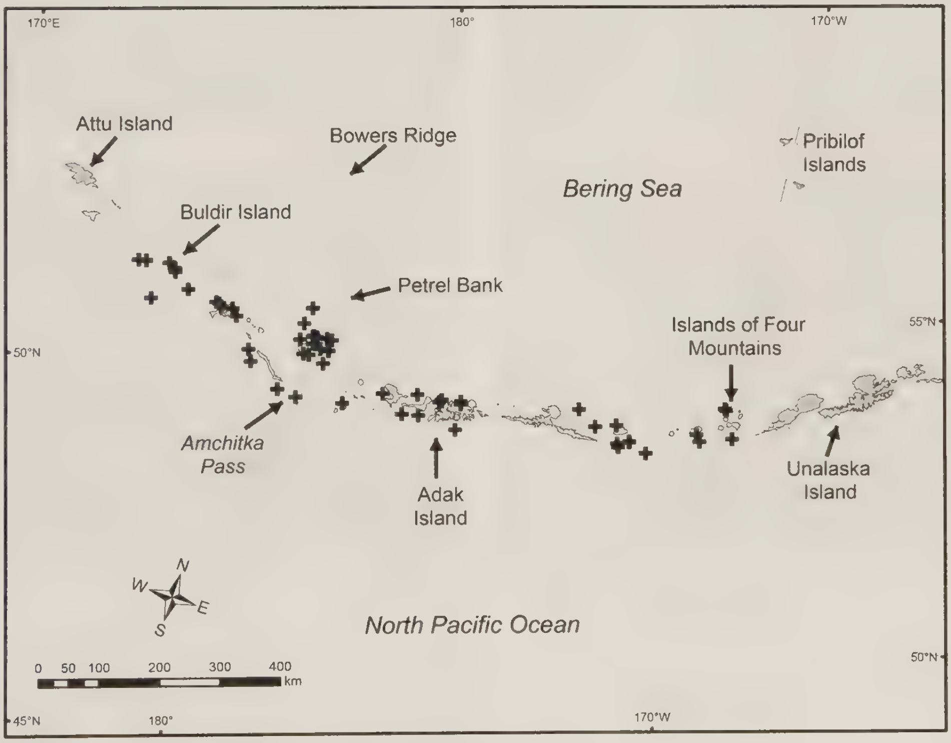
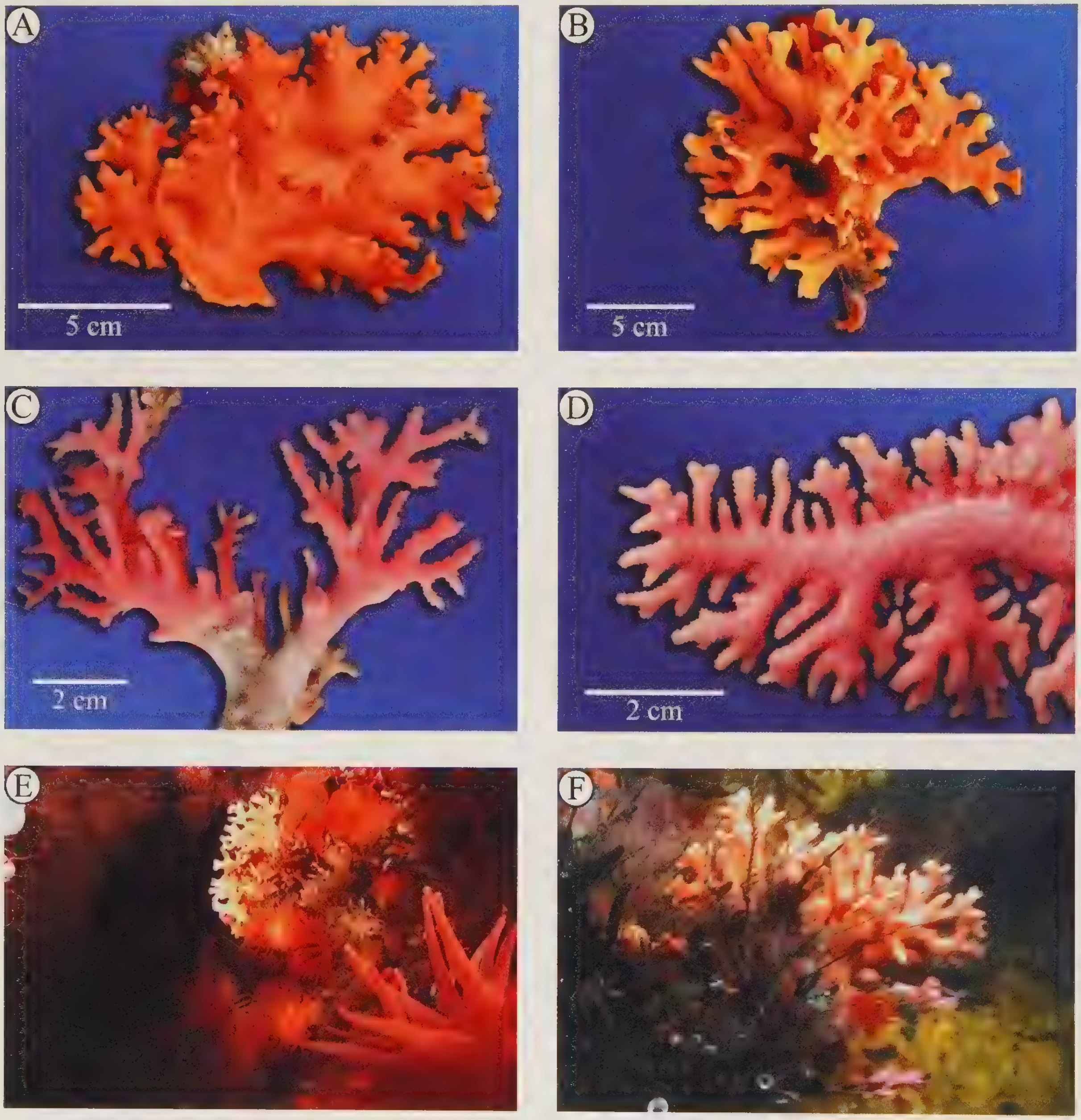


Figure 16-13

A map of the Aleutian Islands showing the distribution of *Errinopora nanneca* (+) in Alaska waters.

22 m. C) A dried whole *E. nanneca* colony (USNM 1223510) collected near Cape Moffet, Adak Island, central Aleutian Islands, at a depth of 150 m. D) A close-up view of a dried *E. nanneca* specimen (USNM 1123450) collected on Amchixtam Chaxsxii in Amchitka Pass, central Aleutian Islands, at a depth of 125 m. E) An *E. nanneca* colony (top, center) photographed near Semisopochnoi Island at a depth of 27 m. F) An *E. nanneca* colony photographed near Semisopochnoi Island at a depth of 27 m.



8. *Errinopora undulata* Lindner and Cairns, 2011

Description (Adapted from Cairns and Lindner, 2011) Colonies are lamellate, with thin sinusoidal distal edges, and a massive basal branch. Colonies are up to 13 cm in height and 15 cm in width. Parasitic spionid polychaete tubes are found in some colonies. The coenosteal texture is reticulate-spinose; the coenosteal strips are separated by wide slits. The coenosteum is light orange.

The gastropores are circular, flush with the coenosteum, and measure 0.3–0.45 mm in diameter; the gastrostyles are lanceolate. The dactylopore spines are clustered around the gastropores in pseudocyclosystems. The dactylopore spines are small (0.25 mm in height) and thin-walled; the dactylostyles are robust.

The female ampullae are irregularly shaped, superficial hemispheres and measure up to 1.6 mm in diameter. Male ampullae are unknown.

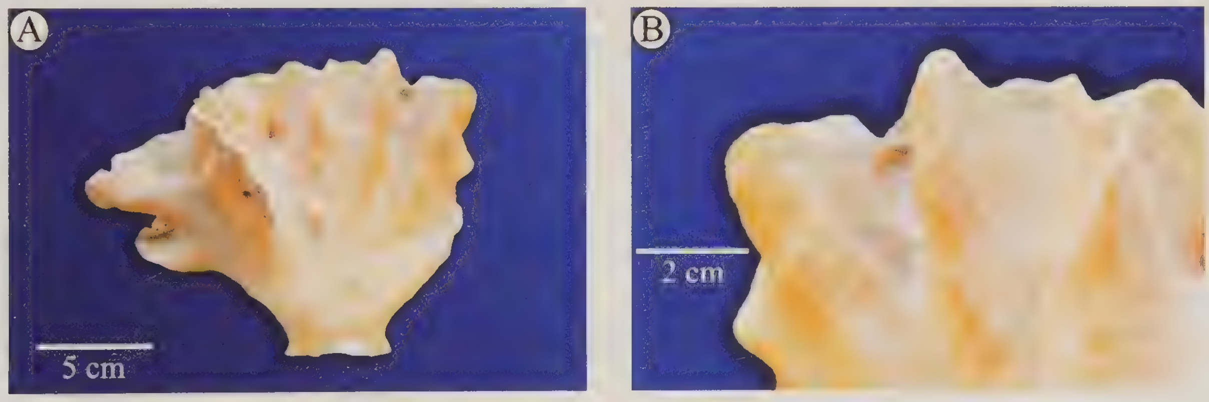
Remarks Only five species of stylasterids have a lamellate corallum and four of those occur in Alaska waters. The gross morphology of *Errinopora undulata* can be confused with *Stylaster repandus* Cairns and Lindner, 2011 or *Cyclohelia lamellata*, but these two species are in other discrete genera with other diagnostic characteristics.

The coenosteum is composed principally (97–98%) of high-magnesium calcite (10.3–10.7 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Rare (known from only three specimens). In Alaska – endemic to the Aleutian Islands (Amukta Pass to west of Semisopochnoi Island; Fig. 16-14). Elsewhere – not reported.

Habitat Largely unknown but attaches to hard rock in areas of moderate to high current and at depths between 366 and 425 m.

Photos A) Most of a whole dried *E. undulata* colony (USNM 1123528; paratype) collected in Amukta Pass, eastern Aleutian Islands, at a depth of 425 m. B) A close-up view of the same specimen in photo A.



8. *Errinopora undulata* Lindner and Cairns, 2011 (continued)

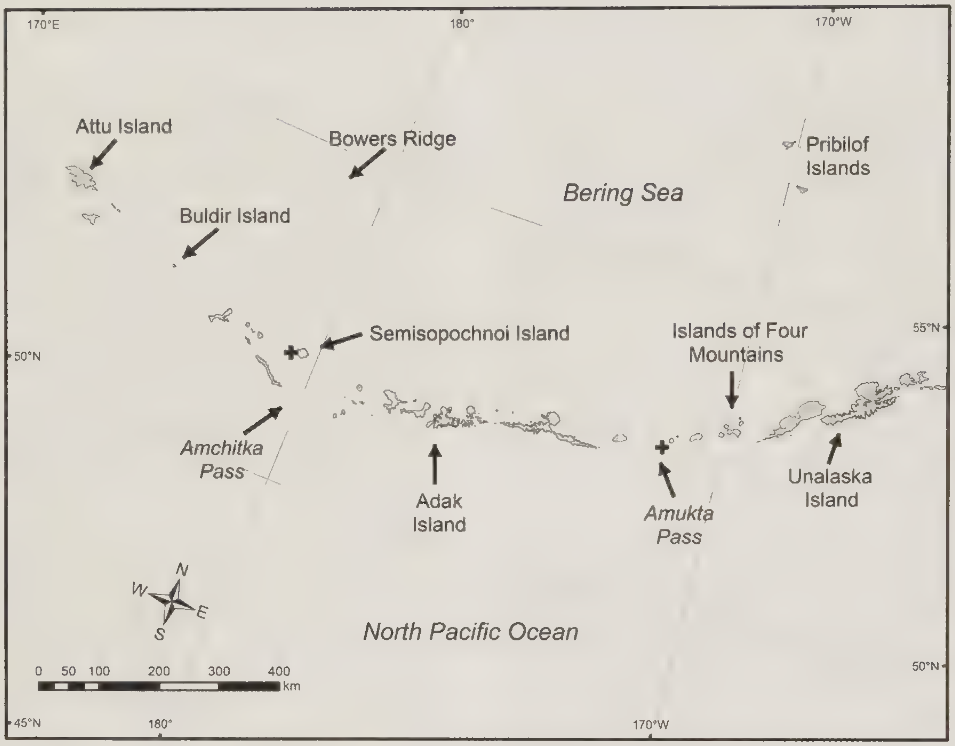

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Semisopochnoi Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-14

A map of the Aleutian Islands showing the distribution of *Errinopora undulata* (+) in Alaska waters.

9. *Errinopora zarhyncha* Fisher, 1938

Description (Adapted from Cairns and Lindner, 2011) Colonies are typically uniplanar but occasionally bushy and quite robust with equal dichotomous branching. Colonies are up to 26 cm in height and 24 cm in width. The branches are thick and have blunt tips. The coenosteal texture is reticulate-spinose and quite porous. The coenosteum is light orange to orange.

The gastropores are circular and quite variable in size, up to 1.1 mm in diameter, and often closely packed and linearly arranged. The gastrostyles are lanceolate but relatively small due to the large diameter of the gastropore tube. The dactylopore spines are quite tall (up to 3 mm in height), thick-walled, and usually laterally fused into transverse tiers flanking the gastropores; compound dactylopore spines are common.

The female ampullae are low hemispherical mounds (up to 1.25 mm in diameter), but are usually overshadowed by an adjacent dactylopore spine; its efferent pore is lateral. The male ampullae are smaller (about 0.6–0.7 mm in diameter) and also superficial.

Remarks *Errinopora zarhyncha* is distinctive among the Alaska *Errinopora* in having a robust colony with very large gastropores and tall dactylopore spines.

The coenosteum is composed principally (95%) of high-magnesium calcite (10.6 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (Cairns and Macintyre, 1992; senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – endemic to the Aleutian Islands (Amukta Pass to Amchitka Island) including Bowers Bank and Ridge (Fig. 16-15). Elsewhere – not reported.

Habitat Typically found singly but occasionally in small patches on hard rock, including bedrock, boulders, and cobbles, in areas of moderate current, and at depths between 115 and 658 m. Video observations (Stone, 2014), however, indicate that this species occurs as deep as 1520 m in the central Aleutian Islands.

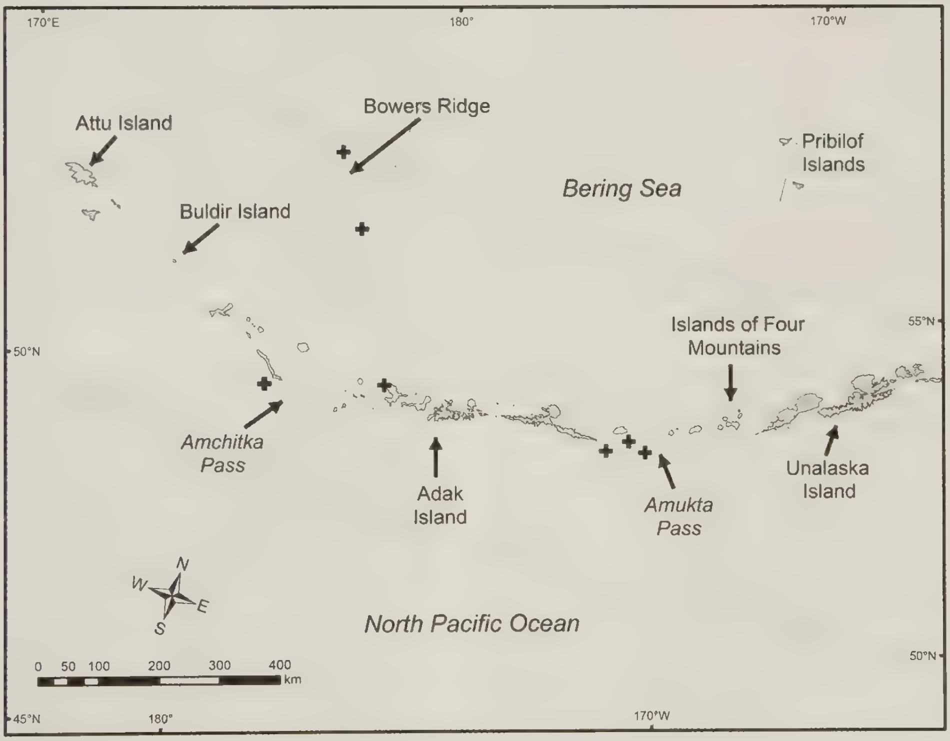
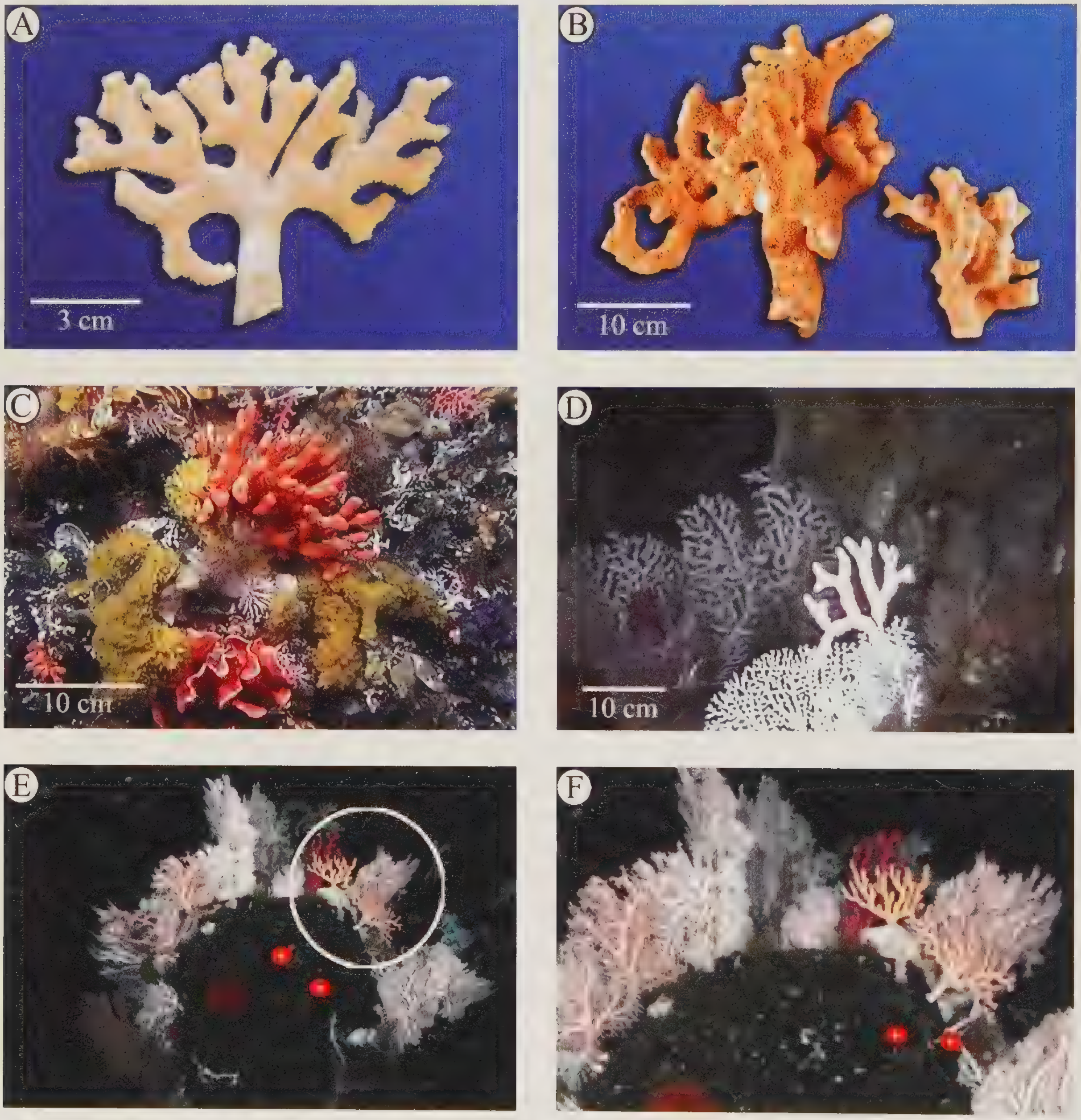

170°E
180°
170°W
Bowers Ridge
Attu Island
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
50°N
0 50 100 200 300 400 km
45°N
180°
170°W

Figure 16-15

A map of the Aleutian Islands showing the distribution of *Errinopora zarhyncha* (+) in Alaska waters.

Photos A) The dried *E. zarhyncha* holotype (USNM 42874; whole colony) collected in Amukta Pass, eastern Aleutian Islands, at a depth of 518 m. B) Two mostly whole dried *E. zarhyncha* colonies (USNM 1123446) collected south of Amlia Island, central Aleutian Islands, at a depth of 497 m. C) An *E. zarhyncha* colony (center, top) photographed northwest of Tanaga Island, central Aleutian Islands, at a depth of 162 m. D) An *E. zarhyncha* colony (center) photographed on Amchixtam Chaxsxii in Amchitka Pass, central Aleutian Islands, at a depth of 862 m. E) *Errinopora zarhyncha* colonies (indicated by the white circle) photographed in northern Amchitka Pass, central Aleutian Islands, at a depth of 830 m. The distance between the red laser marks is 20 cm. F) A closer view of the same colonies in photo E. The distance between the red laser marks is 10 cm.



10. *Stylantheca papillosa* (Dall, 1884)

Description (Adapted from Cairns and Lindner, 2011) Colonies consist of either thin (1–2 mm) encrustations or thicker ones that produce short knobby branches; colonies are up to 30 cm in diameter. The coenosteum is reticulate-granular in texture and covered with short conical papillae (possibly nematopores). The coenosteum is purple, red, or pink and occasionally has white tips on the papillae.

The gastro- and dactylopores are arranged in cyclosystems, measure 0.9–1.2 mm in diameter, and are uniformly distributed on the encrustation. The gastropore tube is about 0.3 mm in diameter, the ring palisade is well developed, and the gastrostyles are globose or triangular. The dactylopores per cyclosystem range from 2 to 12, but usually average 4 to 8; the dactylostyles are quite robust.

Both female (0.7–0.9 mm in diameter) and male (0.4–0.5 mm in diameter) ampullae are internal.

Remarks *Stylantheca papillosa* is the only encrusting stylasterid known in Alaska waters and may be the only encrusting stylasterid worldwide. Junior synonyms for this species include *Stylantheca porphyra* Fisher, 1931 and *Allopora petrograpta* Fisher, 1938. The blue topsnail (*Calliostoma ligatum*) is often associated with *S. papillosa* colonies and may feed on their polyps (senior author, personal observ.).

The coenosteum is composed principally (86–99%) of aragonite with small amounts of low-magnesium calcite and very small amounts of high-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska (Fig. 16-16). The Alaska records represent the northernmost for the species. Elsewhere – British Columbia to northern California (south of San Francisco Bay).

Habitat In Alaska – most common on bedrock in areas of high current and tidal surge, at depths between 6 and 40 m. This is the shallowest stylasterid in Alaska waters. Elsewhere – on bedrock at depths between the lower intertidal zone and 27 m.

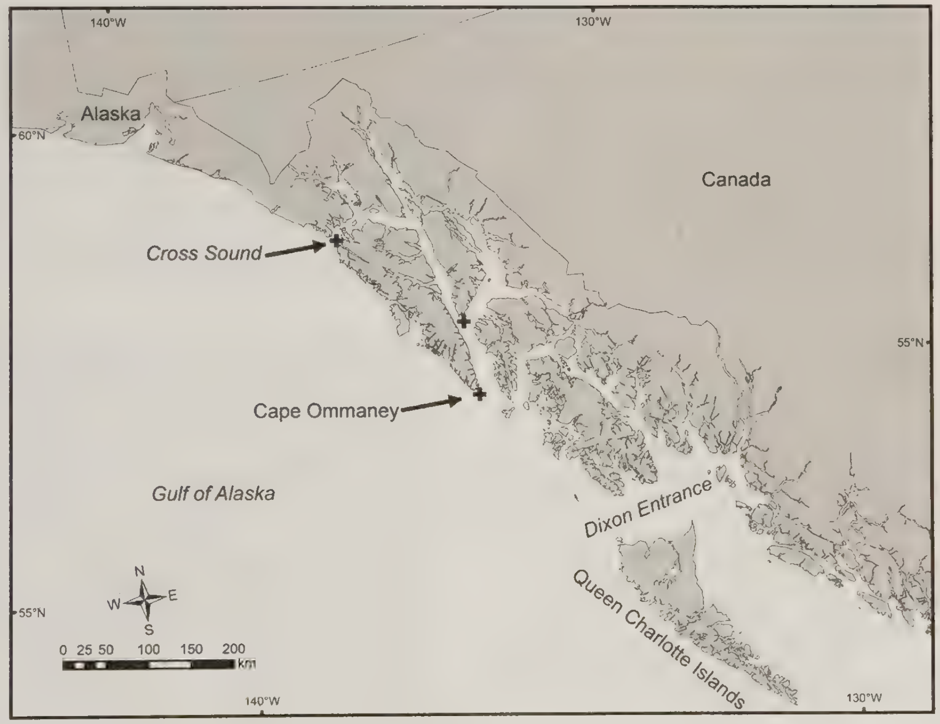
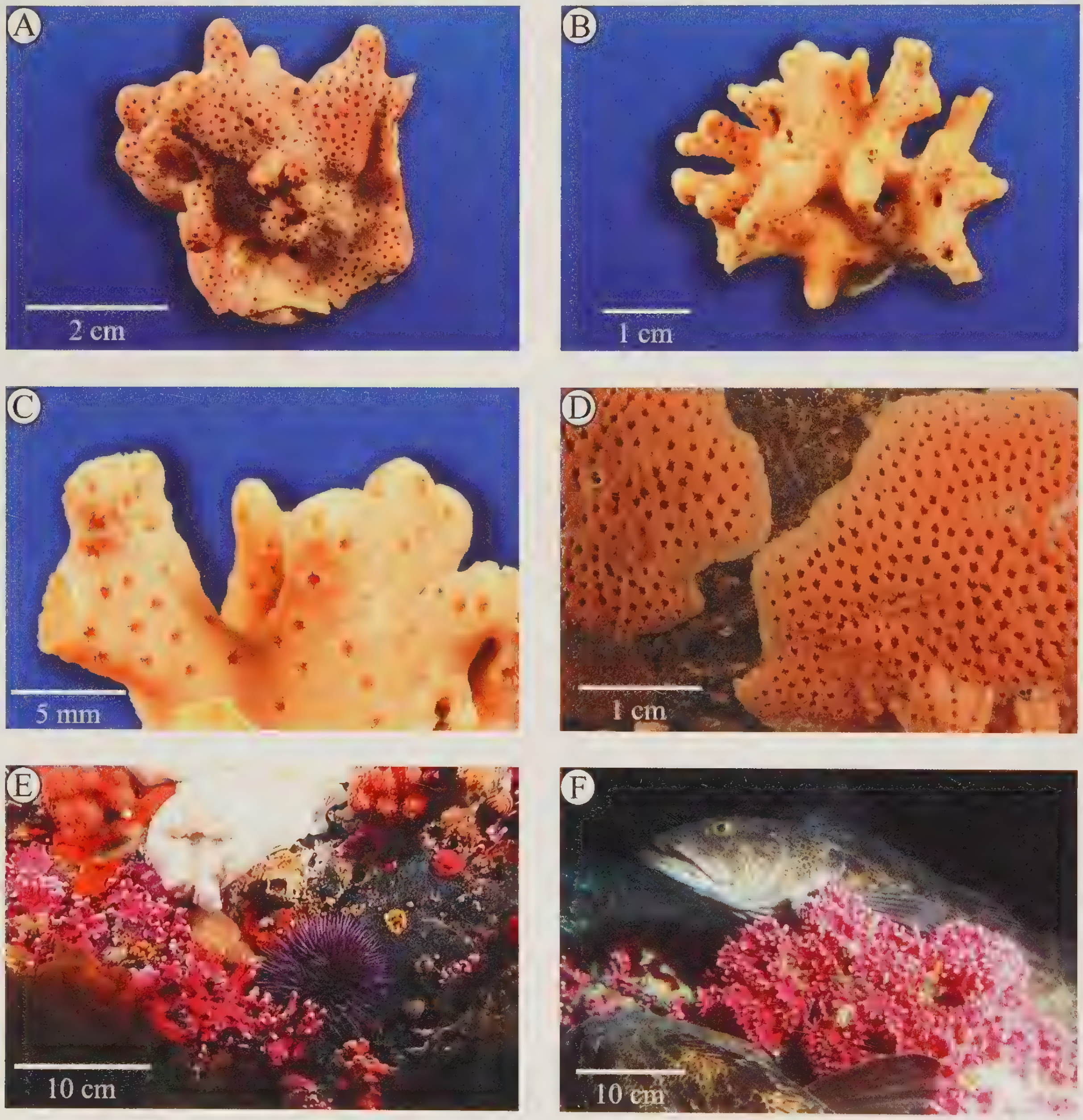


Figure 16-16

A map of the eastern Gulf of Alaska showing the distribution of *Stylantheca papillosa* (+) in Alaska waters.

Photos A) A whole dried *S. papillosa* colony (USNM 1482029) collected near Cape Ommaney, eastern Gulf of Alaska, at a depth of 18 m. B) A whole dried *S. papillosa* colony (USNM 1482032) collected near Cross Sound, eastern Gulf of Alaska, at a depth of 18 m. C) A close-up view of the same specimen in photo B. D) A close-up view of a dried *S. papillosa* specimen (USNM 148202) collected in Burrard Inlet, British Columbia, at a depth of 18 m. E) A patch of *S. papillosa* colonies (including USNM 1482029) at a depth of 18 m near Cape Ommaney. F) Adult lingcod (*Ophiodon elongatus*) rest on a large patch of *S. papillosa* in the Edgecumbe Pinnacles Marine Reserve near Sitka, Alaska. The depth is approximately 40 m and thus extends the depth range for the species.



11. *Stylaster alaskanus* Fisher, 1938

Description (Adapted from Cairns and Lindner, 2011) Colonies are uniplanar, or dichotomously branched and highly anastomotic, forming a sieve-like reticulum. The largest known specimen is 60 cm in height and width but larger colonies have been observed in situ (see photo C on next page). The coenosteum is linear-imbricate in texture and light orange, pink, or creamy white in color.

The gastro- and dactylopores are arranged in cyclosystems that are linearly arranged on the branch edges only. Cyclosystems are irregular in shape and 0.9–1.3 mm in diameter. The gastropore tubes are funnel-shaped, with a prominent ring palisade and a lanceolate gastrostyle. The range of dactylopores per cyclosystem is 7–14, but averages about 11; dactylostyles are rudimentary.

The female ampullae are superficial hemispheres up to 0.9 mm in diameter, often bear low ridges or short spines, and have a lateral efferent pore. The male ampullae are also superficial, up to 0.6 mm in diameter, and usually densely clustered.

Remarks *Stylaster alaskanus* differs from other Alaska species in having a reticulate colony and ornamented female ampullae. It was previously known as *Stylaster cancellatus* Fisher, 1938.

Associated fauna include ophiuroids. The reproductive ecology of this species has been studied from colonies collected in the Aleutian Islands (Brooke and Stone, 2007). The coenosteum is composed principally (99–100%) of aragonite with very small amounts of low- and high-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Common. In Alaska – endemic to the Aleutian Islands (Amukta Pass to east of Stalemate Bank) including Petrel Bank and Bowers Ridge (Fig. 16-17). Elsewhere – not reported.

Habitat *Stylaster alaskanus* is often found in complex habitat and is a good indicator species of coral garden habitat. It is typically found singly but occasionally in small patches on hard rock, including bedrock, boulders, and cobbles, in areas of moderate current, and at depths between 146 and 2124 m.

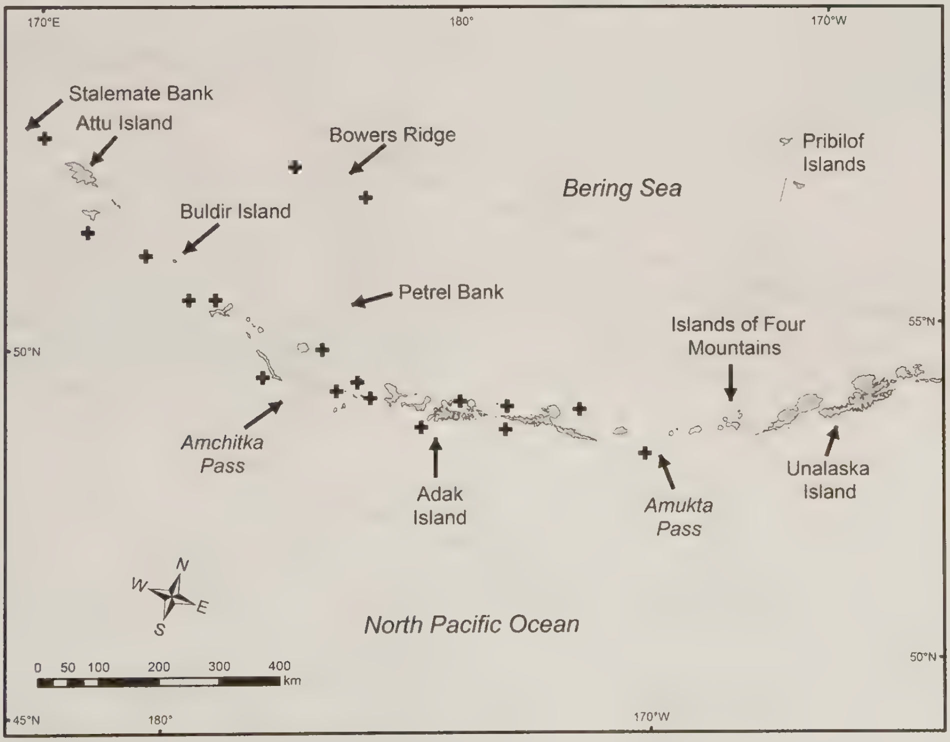
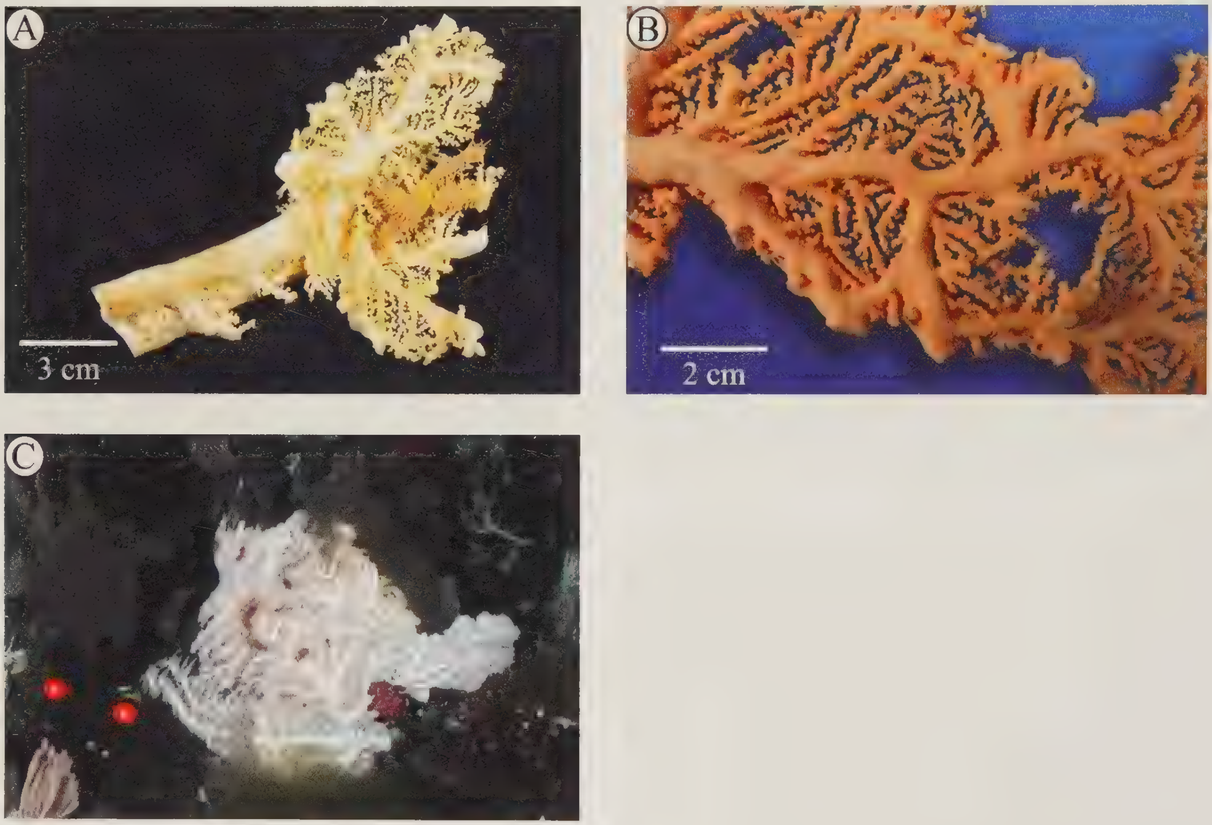

170°E
180°
170°W
Stalemate Bank
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
50°N
0 50 100 200 300 400 km
45°N
180°
170°W

Figure 16-17

A map of the Aleutian Islands showing the distribution of *Stylaster alaskanus* (+) in Alaska waters.

Photos A) A large fragment of a dried *S. alaskanus* colony (USNM 1122455) collected south of Amchitka Island, western Aleutian Islands, at a depth of 265 m. B) A close-up view of a dried *S. alaskanus* specimen (USNM 1122466) collected west of Kiska Island, western Aleutian Islands, at a depth of 256 m. C) A large *S. alaskanus* colony (70 cm in height by 74 cm in width) photographed in northern Amchitka Pass in the central Aleutian Islands at a depth of 712 m. The distance between the red laser marks is 20 cm.



12. *Stylaster brochi* (Fisher, 1938)

Description (Adapted from Cairns and Lindner, 2011) Colonies are variable in shape, ranging from uniplanar branching to bushy, with irregular dichotomous branching; the largest known colony is 28 cm in height. All colonies are infested with the spionid polychaete *Polydora*, which forms characteristic binary tubes along most branch axes. The coenosteum has a reticulate-granular texture and is pale orange in color.

The gastro- and dactylopores are arranged in cyclosystems that are uniformly arranged on all branch surfaces; cyclosystems are 0.9–1.4 mm in greater diameter. The gastropore tubes are cylindrical, elongate, and usually curved, containing a diffuse ring palisade and an elongate gastrostyle. The range of dactylopores per cyclosystem is 6–13, but averages about 9; the dactylostyles are well developed.

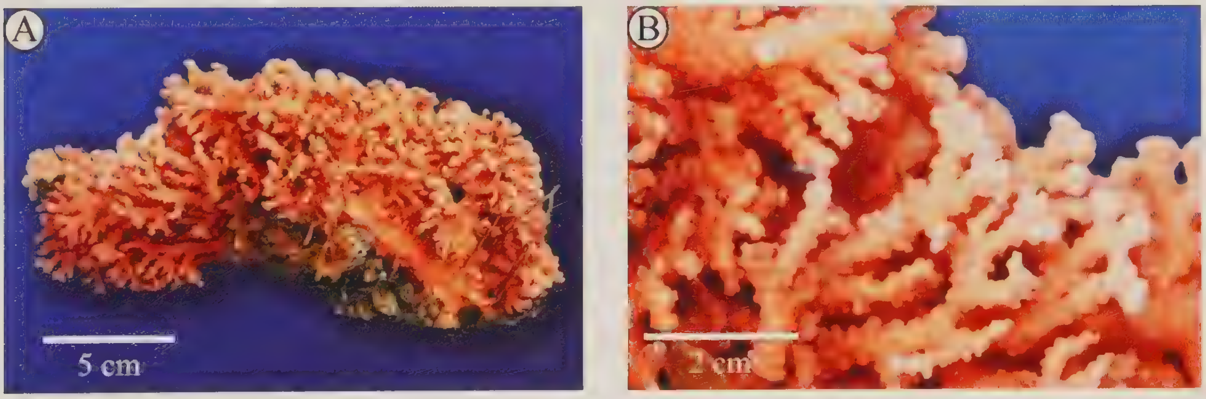
The female ampullae are superficial mounds (0.8–1.1 mm in diameter) and each has a lateral efferent pore. The male ampullae are clustered, primarily internal, and measure 0.3–0.5 mm in diameter.

Remarks *Stylaster brochi* is one of four Alaska species to have its cyclosystems arranged uniformly on all branch surfaces, and thus belonged to the genus previously called *Allopora*. The reproductive ecology of this species has been studied from colonies collected in the Aleutian Islands (Brooke and Stone, 2007). The coenosteum is composed principally (88–99%) of aragonite with small amounts of low-magnesium calcite and very small amounts of high-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Very common and widespread. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, western Gulf of Alaska, and throughout the Aleutian Islands including Petrel Bank (Fig. 16-18). Elsewhere – not reported.

Habitat Typically found in small patches on hard rock including bedrock, boulders, and cobbles, in areas of moderate current, and at depths between 20 and 455 m.

Photos A) A dried whole *S. brochi* colony (USNM 1482034) collected near Semisopochnoi Island, central Aleutian Islands, at a depth of 22 m. B) A close-up view of the same specimen in photo A.



12. *Stylaster brochi* (Fisher, 1938) (continued)

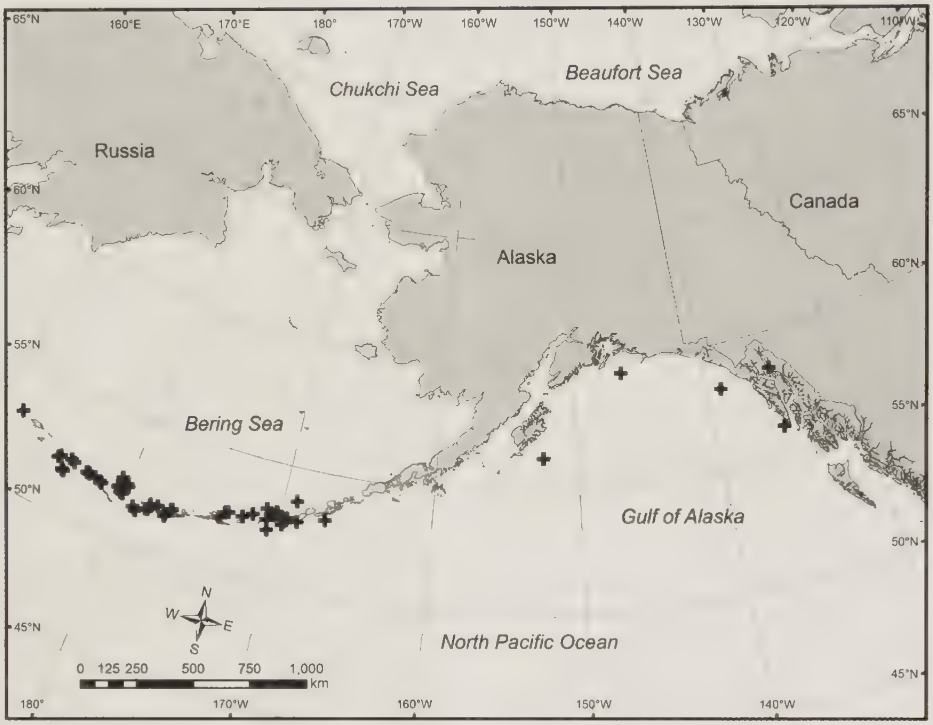

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Chukchi Sea
Beaufort Sea
65°N
Russia
60°N
Canada
Alaska
60°N
55°N
55°N
Bering Sea
50°N
Gulf of Alaska
50°N
N
W
E
S
45°N
North Pacific Ocean
0 125 250 500 750 1,000
km
45°N
180°
170°W
160°W
150°W
140°W

Figure 16-18

A map of the North Pacific Ocean showing the distribution of *Stylaster brochi* (✚) in Alaska waters.

13. *Stylaster campylecus* (Fisher, 1938)

Description (Adapted from Cairns and Lindner, 2011) Colonies branch dichotomously in a uniplanar or multiplanar fashion; in large colonies these branches sometimes anastomose. The largest known colony (USNM 1482002) is 50 cm in height and 38 cm in width. The coenosteal texture is reticulate-granular to porcelaneous; however, the coenosteal strips are longitudinally arranged on the abaxial side of cyclosystems. The coenosteum is white, pale orange, pale pink, and occasionally bright pink.

The gastro- and dactylopores are arranged in cyclosystems located on branch edges as well as the anterior face; the cyclosystems measure 1.0–1.3 mm in diameter. The gastropore tubes are cylindrical and curved, often containing a poorly developed ring palisade and a short, stout gastrostyle. The range of dactylopores per cyclosystem is 7–17, but averages about 12; dactylostyles are rudimentary.

The female ampullae are large (1.0–1.1 mm in diameter) superficial hemispheres and each has a lateral efferent pore. The male ampullae are also superficial, measure 0.4–0.5 mm in diameter, and are usually clustered on anterior branch faces.

Remarks *Stylaster campylecus* is distinctive in having longitudinally arranged coenosteal strips on the abaxial side of the cyclosystems. This species is also known as *S. polyorchis* (Fisher, 1938), *S. moseleyanus* (Fisher, 1938), *S. campylecus tylotus* (Fisher, 1938), and *S. campylecus campylecus* (Fisher, 1938). The reproductive ecology of this species has been studied from colonies collected in the Aleutian Islands (Brooke and Stone, 2007). The coenosteum is composed principally (87–99%) of aragonite with small amounts of low-magnesium calcite and very small amounts of high-magnesium calcite (Cairns and Macintyre, 1992; senior author and S. D. Cairns, unpubl. data).

Distribution Common, abundant in some areas, and widespread. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska, western Gulf of Alaska, and throughout the Aleutian Islands including Petrel and Bowers Banks (Fig. 16-19). Elsewhere – not reported.

Habitat Typically found in patches on hard rock including bedrock, boulders, cobbles, and pebbles, in

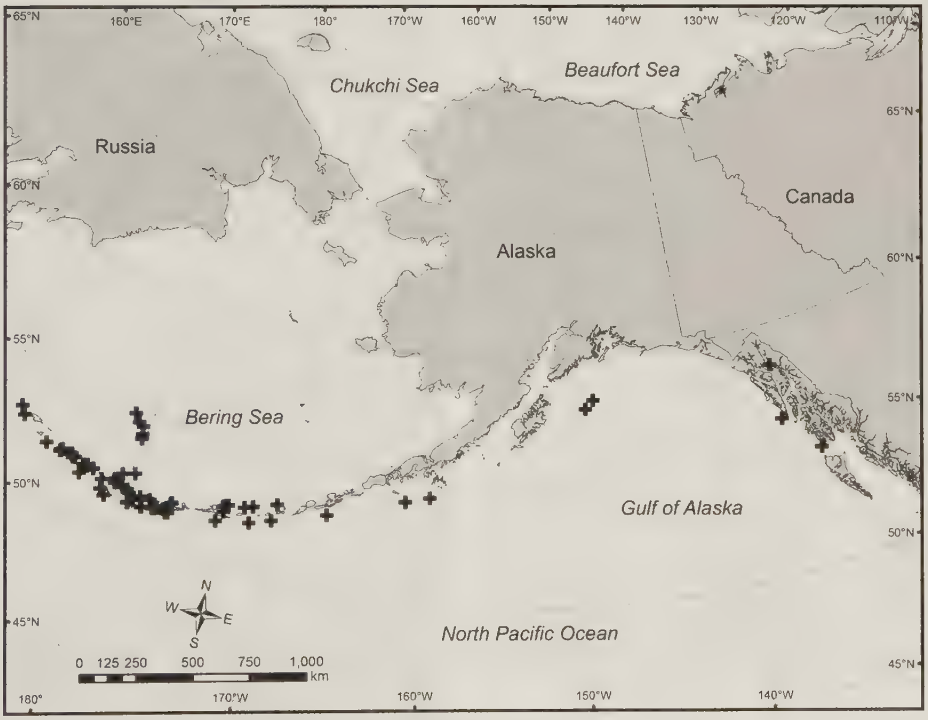
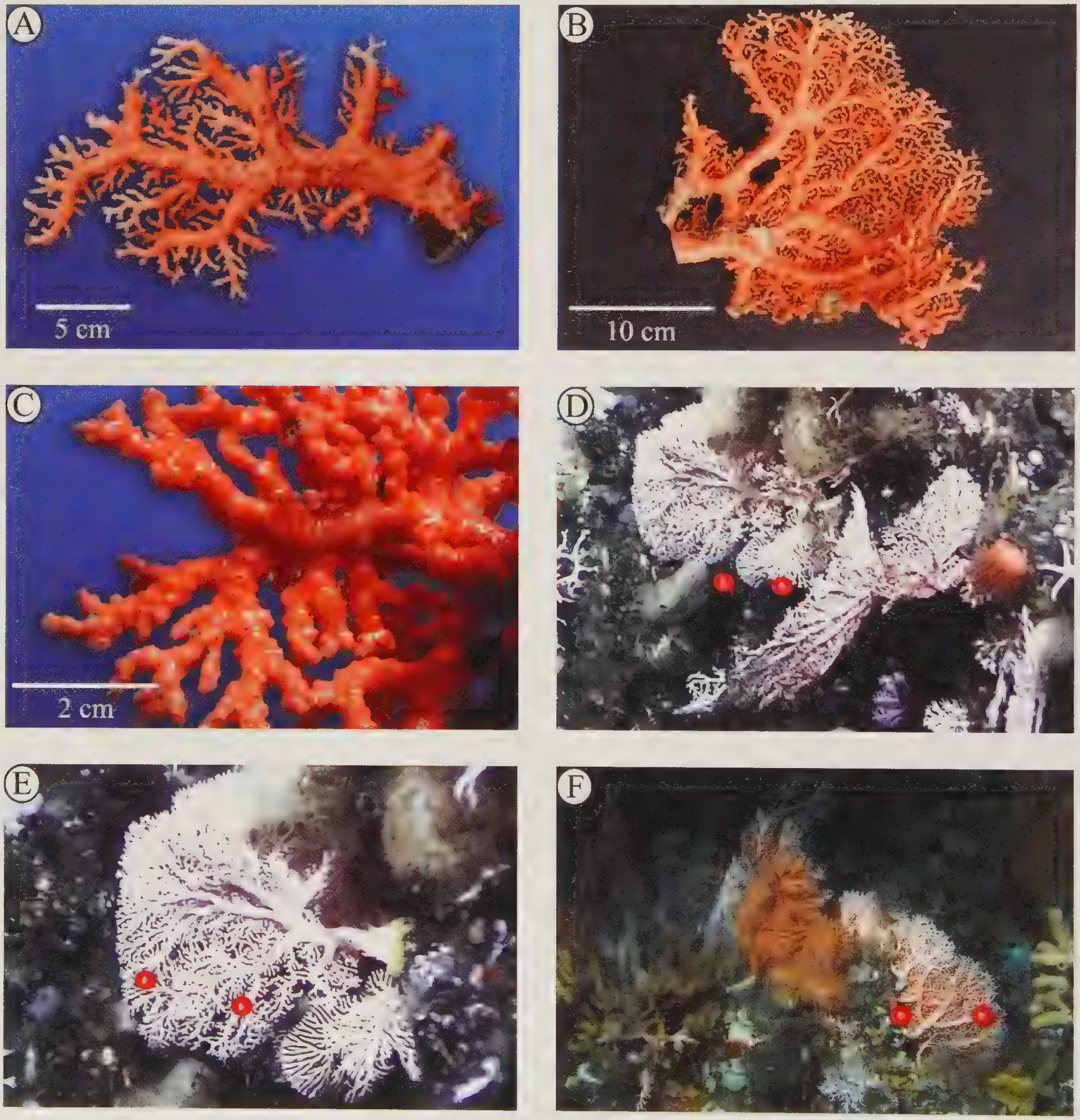


Figure 16-19

A map of the North Pacific Ocean showing the distribution of *Stylaster campylecus* (+) in Alaska waters.

areas of moderate current, and at depths between 79 and 1396 m.

Photos A) A large portion of a *S. campylecus* colony (USNM 1481994) collected in southern Amchitka Pass, central Aleutian Islands, at a depth of 115 m. B) A large portion of a *S. campylecus* colony (USNM 1481992) collected on Petrel Bank, central Aleutian Islands, at a depth of 145 m. C) A close–up view of a *S. campylecus* specimen collected near Cape Moffet, Adak Island, central Aleutian Islands, at a depth of 150 m. D) A patch of *S. campylecus* colonies at a depth of 681 m in the central Aleutian Islands. E) A close-up view of a large *S. campylecus* colony in photo D. F) A small patch of *S. campylecus* colonies near the Delarof Islands, southern Amchitka Pass, central Aleutian Islands, at a depth of 165 m. The distance between the red laser marks in photos D–F is 10 cm.



14. *Stylaster crassiseptum* Cairns and Lindner, 2011

Description (Adapted from Cairns and Lindner, 2011) Colony branching is uniplanar, in an irregular dichotomous fashion; the largest known specimen is 24 cm in height and 19 cm in width. The coenosteal texture is reticulate-granular, sometimes almost porcellaneous; the coenosteum is pale orange.

The gastropores and dactylopores are arranged in cyclosystems that occur exclusively on opposite branch edges; the cyclosystems are only 0.7–1.0 mm in diameter. The gastropore tubes are cylindrical and slightly curved, each containing a well-developed ring palisade and a lanceolate gastrostyle. The range of dactylopores per cyclosystem is 6–12, but averages about 9; the dactylostyles are robust. Pseudosepta are broad and rounded, and some are up to five times the width of the adjacent dactylotome.

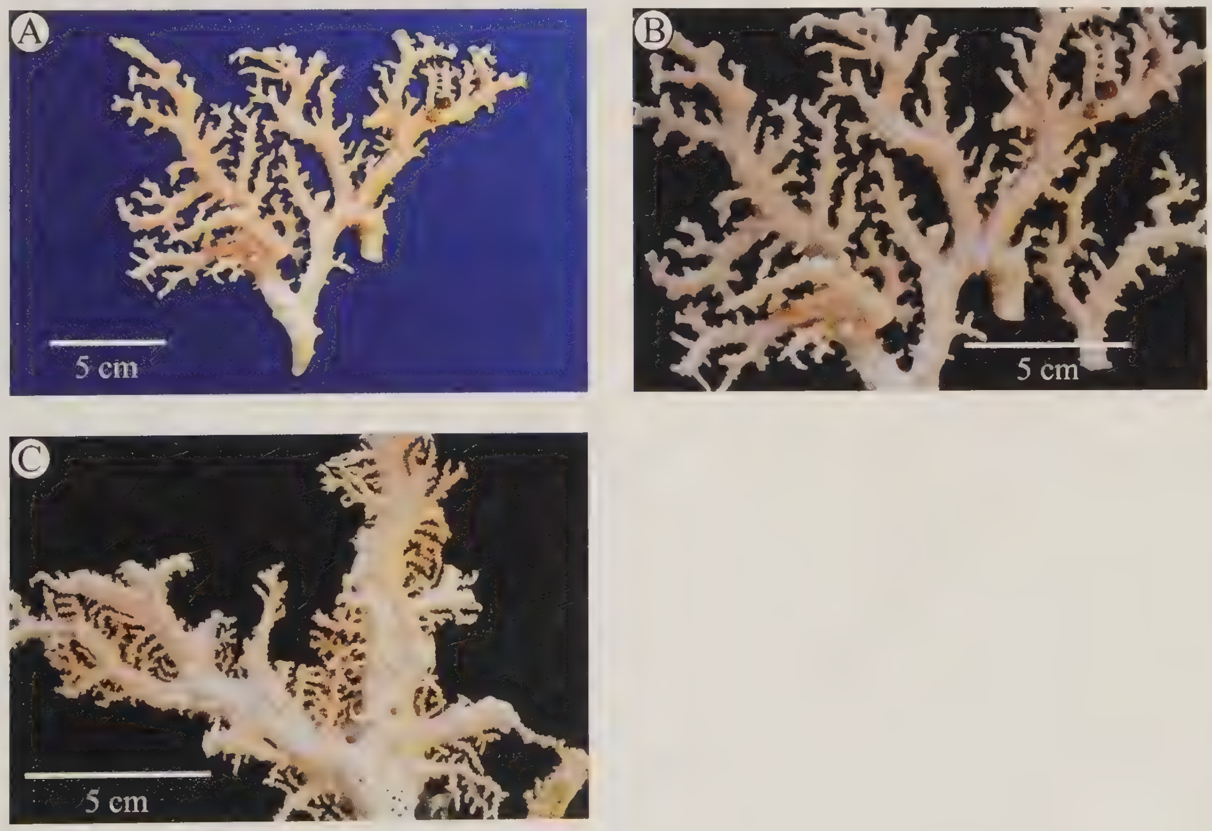
The female ampullae are superficial hemispheres and measure 0.9–1.1 mm in diameter. The male ampullae are also superficial, measure 0.45–0.50 mm in diameter, and are often clustered.

Remarks *Stylaster crassiseptum* is distinctive in having very broad pseudosepta. The coenosteum is composed entirely of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Rare. In Alaska – known from only six specimens collected in the Aleutian Islands (south of Atka Island to west of Kiska Island) and on Bowers Bank (Fig. 16-20). It is apparently endemic to the region. Elsewhere – not reported.

Habitat Largely unknown but likely found singly or in small patches on hard rock including bedrock and boulders, in areas of moderate current, and at depths between 291 and 531 m.

Photos A) A large portion of a dried *S. crassiseptum* colony (USNM 1122497; paratype) collected on Bowers Bank, central Aleutian Islands, at a depth of 291 m. B) A close-up view of the same specimen in photo A. C) A large portion of a dried *S. crassiseptum* colony (USNM 1122527; paratype) collected south of Atka Island, central Aleutian Islands, at a depth of 531 m.



14. *Stylaster crassiseptum* Cairns and Lindner, 2011 (continued)

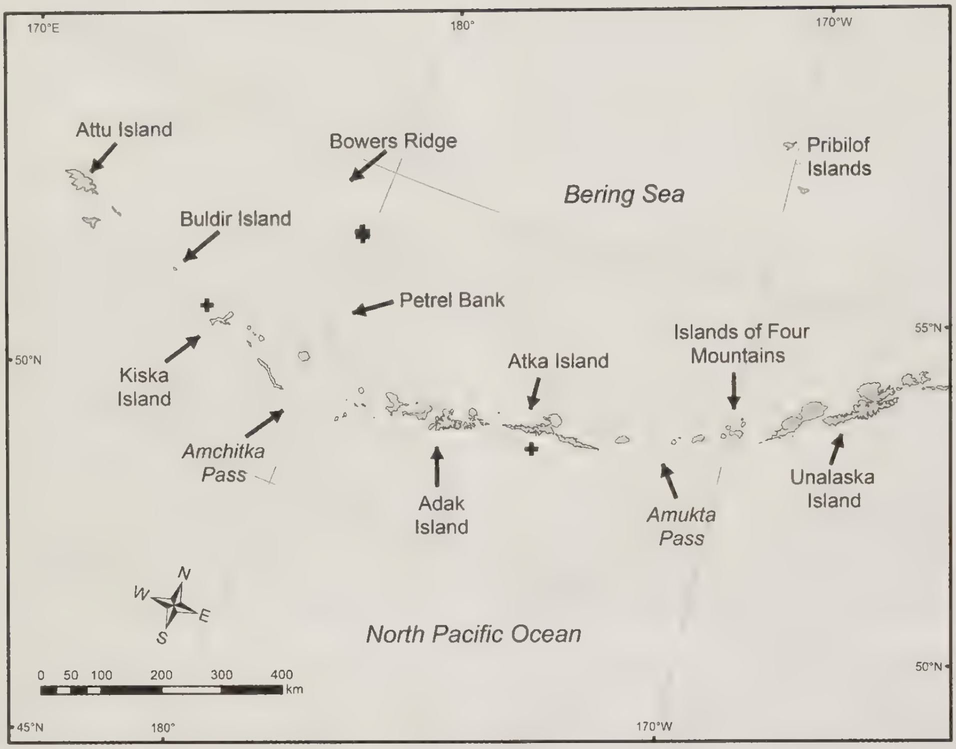

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Atka Island
Kiska Island
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-20

A map of the Aleutian Islands showing the distribution of *Stylaster crassiseptum* (+) in Alaska waters.

15. *Stylaster elassotomus* Fisher, 1938

Description The holotype is a bushy colony with irregular, dichotomous branching and measures 5.5 cm in height and about 5 cm in width. The coenosteum has a reticulate-granular texture and is white in color.

The gastro- and dactylopores are arranged in circular to slightly elliptical cyclosystems located exclusively on the two branch edges; the cyclosystems are 1.0–1.2 mm in greater diameter. The gastropores are quite large (up to 0.6 mm in diameter); the gastropore tubes are cylindrical and highly curved and each contains a delicate ring palisade and a slender gastrostyle. The range of dactylopores per cyclosystem is 11–17, but averages about 14; the dactylostyles are inconspicuous.

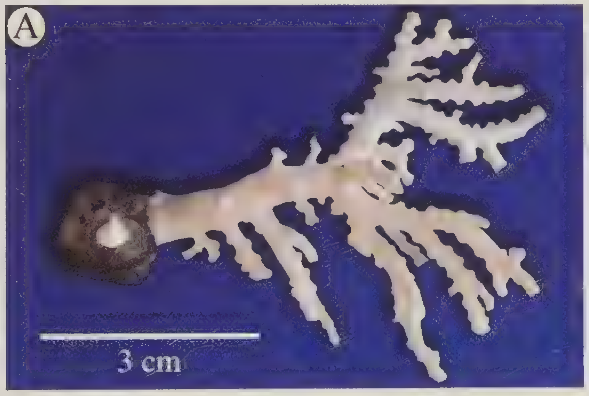
Female ampullae are unknown. The male ampullae are small (0.5–0.6 mm in diameter) superficial hemispheres.

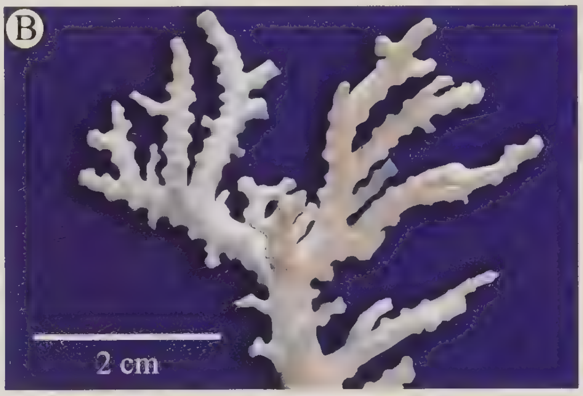
Remarks *Stylaster elassotomus* is distinctive among the Alaska species in having large gastropores and relatively short dactylotomes.

Distribution Extremely rare. In Alaska – known from only a single specimen collected southeast of Agattu Island in the western Aleutian Islands (Fig. 16-21). It is apparently endemic to the region. Elsewhere – not reported.

Habitat Largely unknown but likely found singly or in small patches on hard rock including bedrock, boulders, cobbles, and pebbles, in areas of moderate current, and at depths around 881 m.

Photos A) The dried *S. elassotomus* holotype (USNM 43268; large portion of a colony) collected southeast of Agattu Island, western Aleutian Islands, at a depth of 881 m. B) A close-up view of the same specimen in photo A.





15. *Stylaster elassotomus* Fisher, 1938 (continued)

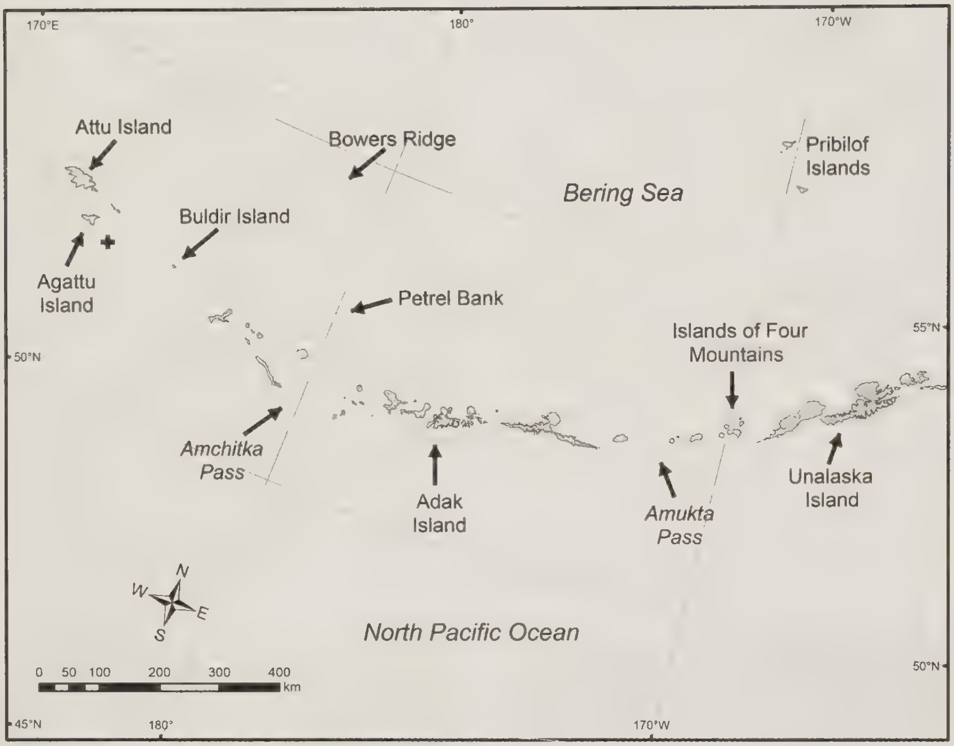

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Agattu Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-21

A map of the Aleutian Islands showing the distribution of *Stylaster elassotomus* (+) in Alaska waters.

16. *Stylaster leptostylus* (Fisher, 1938)

Description Colonies branch in a uniplanar and equal dichotomous manner; the largest known colony is 13 cm in height. The coenosteum has a reticulate-granular texture and is white in color.

The gastro- and dactylopores are arranged in circular cyclosystems on branch edges and the anterior face; the cyclosystems are 1.0–1.1 mm in diameter. The gastropore tubes are slightly curved and funnel-shaped and each houses a lanceolate gastrostyle; a ring palisade is absent. The range of dactylopores per cyclosystem is 7–12, but averages about 10; the dactylostyles are of moderate size.

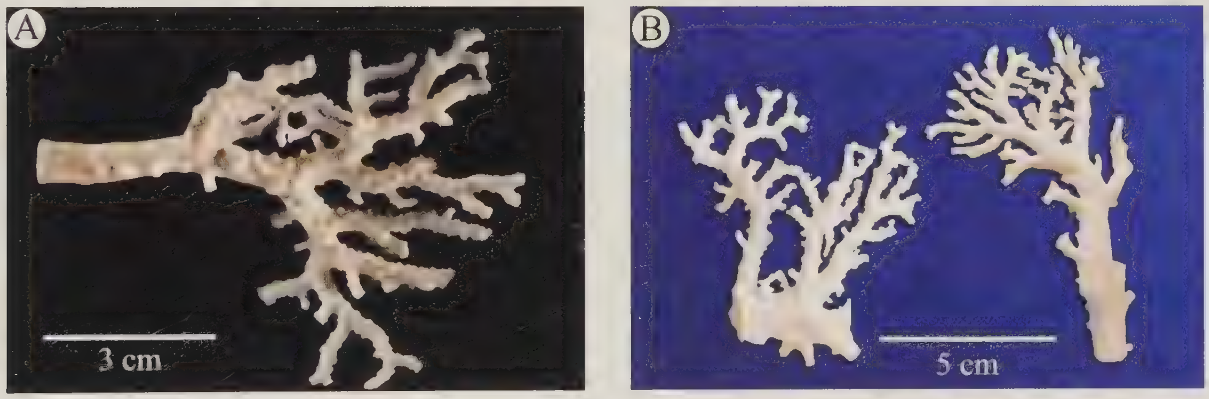
The female ampullae are smooth superficial hemispheres measuring 0.9–1.1 mm in diameter. The male ampullae are superficial mounds and measure 0.45–0.55 mm in diameter.

Remarks This species was originally described as a form of *Stylaster moseleyanus* but later elevated to species rank by Cairns and Lindner (2011). It is most similar to *S. campylecus*, but differs in having fewer dactylopores per cyclosystem.

Distribution Rare. In Alaska – known only from the seven type specimens collected at the same location in Amukta Pass in the eastern Aleutian Islands (Fig. 16-22). It is apparently endemic to the region. Elsewhere – not reported.

Habitat Largely unknown but likely found singly or in small patches on hard rock including bedrock, boulders, cobbles, and pebbles, in areas of moderate current, and at depths around 518 m.

Photos A) The dried *S. leptostylus* holotype (USNM 43270; large portion of a colony) collected in Amukta Pass, eastern Aleutian Islands, at a depth of 518 m. B) Large portions of dried *S. leptostylus* colonies (USNM 76817; paratypes) collected in Amukta Pass at a depth of 518 m.



16. *Stylaster leptostylus* (Fisher, 1938) (continued)

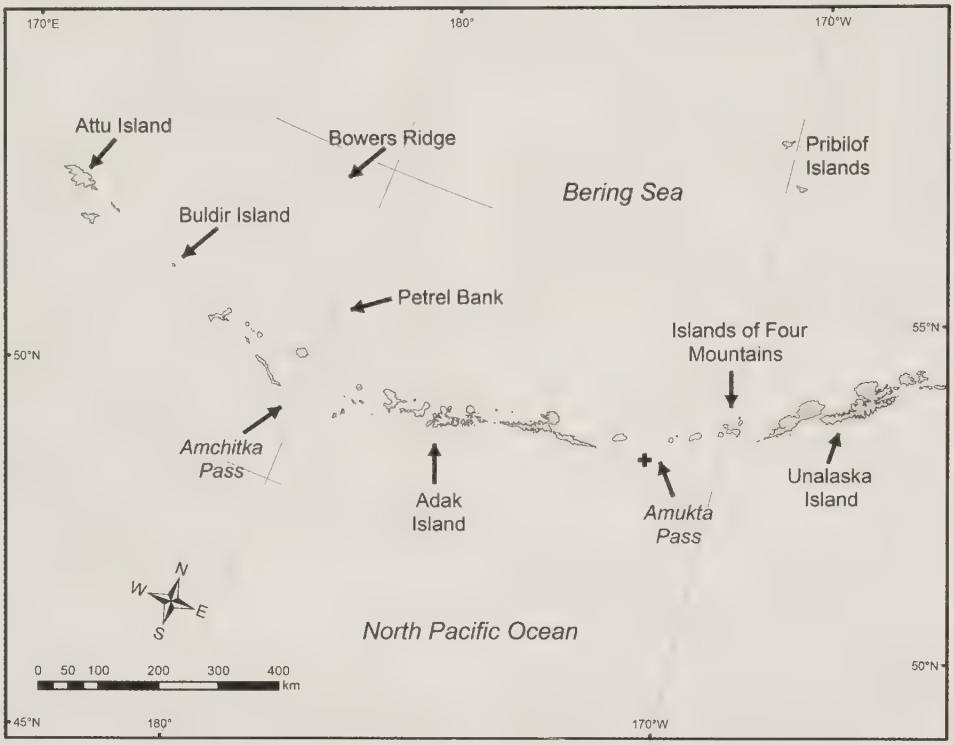

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-22

A map of the Aleutian Islands showing the distribution of *Stylaster leptostylus* (+) in Alaska waters.

17. *Stylaster parageus columbiensis* Cairns and Lindner, 2011

Description (Adapted from Cairns and Lindner, 2011) See description of the nominate subspecies (*Stylaster parageus parageus*) and Remarks. Colonies are relatively small, only measuring up to 8.5 cm in height and 8 cm in width. The color of the coenosteum is white in life but turns a creamy orange in ethanol-preserved specimens.

Remarks This subspecies differs from the nominate subspecies by having larger cyclosystems (1.0–1.5 mm in diameter), larger gastropores (0.45–0.50 mm in diameter), and a slightly higher number of dactylopores per cyclosystem (6–13, average=9). It also ranges considerably further south (approximately 1400 km) than the nominate subspecies (Cairns and Lindner, 2011).

The coenosteum is composed entirely of aragonite (senior author and S. D. Cairns, unpubl. data).

Distribution Common, abundant in some areas. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska (Fig. 16-23). Elsewhere – British Columbia to northern Washington.

Habitat In Alaska – typically occurs in patches, often on rocky bedrock pinnacles, in areas of moderate to strong current, and at depths between 92 and 439 m. Observed on video footage collected on Shutter Ridge as shallow as 88 m (senior author, personal observ.). Elsewhere – reported at depths between 246 and 288 m.

Photos A) Large portions of dried *S. p. columbiensis* colonies (USNM 1291726) collected on Shutter Ridge, eastern Gulf of Alaska, at a depth of 92 m. B) A close-up view of the leftmost specimen in photo A. C) *Stylaster p. columbiensis* colonies photographed on Shutter Ridge at a depth of 88 m. D) A close-up view of a colony in photo C (between the red laser marks). E) A closer view of the same specimen in photo D. F) A patch of *S. p. columbiensis* on a rocky pinnacle on Shutter Ridge. The distance between the red lasers marks in photos C, D, and F is 10 cm.

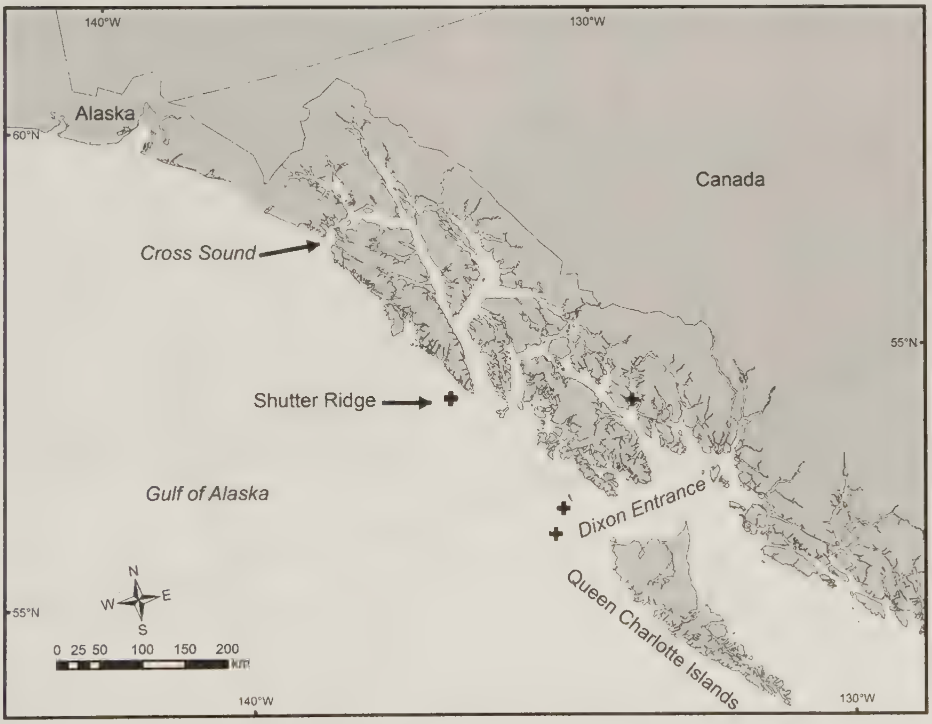
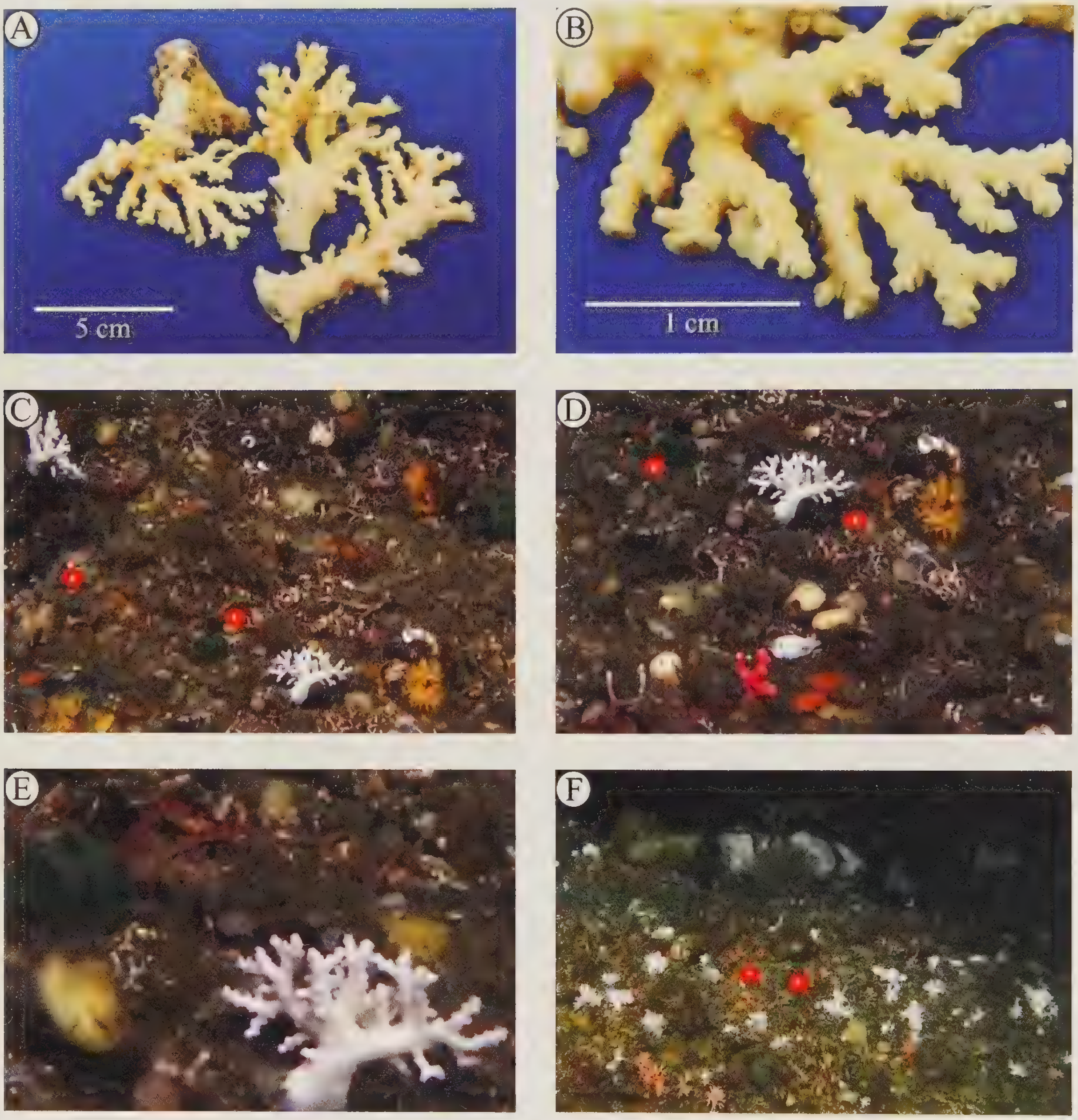


Figure 16-23

A map of the eastern Gulf of Alaska showing the distribution of *Stylaster parageus columbiensis* (**+**) in Alaska waters.

17. *Stylaster parageus columbiensis* Cairns and Lindner, 2011 (continued)


A
5 cm
B
1 cm
C
D
E
F

18. *Stylaster parageus parageus* (Fisher, 1938)

Description (Adapted from Cairns and Lindner, 2011) Colonies branch in a uniplanar or multiplanar manner, often with short branchlets oriented perpendicular to the flabella (or fans); branching is delicate and dichotomous. Colonies are relatively large, measuring up to 19 cm in height and 22 cm in width. Spionid polychaete tubes are common. The coenosteal texture is reticulate-granular; the coenosteum is white to light pink in color.

The gastro- and dactylopores are arranged in circular cyclosystems on branch edges and the anterior face; the cyclosystems are 0.9–1.0 mm in diameter. The gastropores are quite small (0.3 mm in diameter); the gastropore tubes are cylindrical, slightly curved, and each contains a well-developed ring palisade and a lanceolate gastrostyle. The range of dactylopores per cyclosystem is 5–11 and averages about 8; the dactylostyles are well developed.

The female ampullae are superficial hemispheres (0.8–1.0 mm in diameter) and each has a lateral efferent pore. The male ampullae are mostly internal and about 0.5 mm in diameter.

Remarks Originally described as the "southern shallow-water race" of *S. campylecus* by Fisher (1938), the subspecies *parageus* was elevated to species rank by Cairns and Lindner (2011). It is distinctive in having very small gastropores.

The coenosteum is composed almost entirely (92–100%) of aragonite with very small amounts of low-magnesium calcite (senior author and S. D. Cairns, unpubl. data). Studies of this species growth indicate that the periodicity of skeletal growth bands is monthly, radial growth rates are 1.4 mm/year (standard deviation [SD] 0.1), and axial growth rates are 17.3 mm/year (SD 1.1) (Aranha, 2010).

Distribution Common, locally abundant. In Alaska – eastern Gulf of Alaska including the inside waters of Southeast Alaska to south of Resurrection Bay in the western Gulf of Alaska (Fig. 16-24). Elsewhere – northern British Columbia near the border with Southeast Alaska.

Habitat In Alaska – typically occurs in patches, sometimes dense, on rocky bedrock pinnacles and other hard

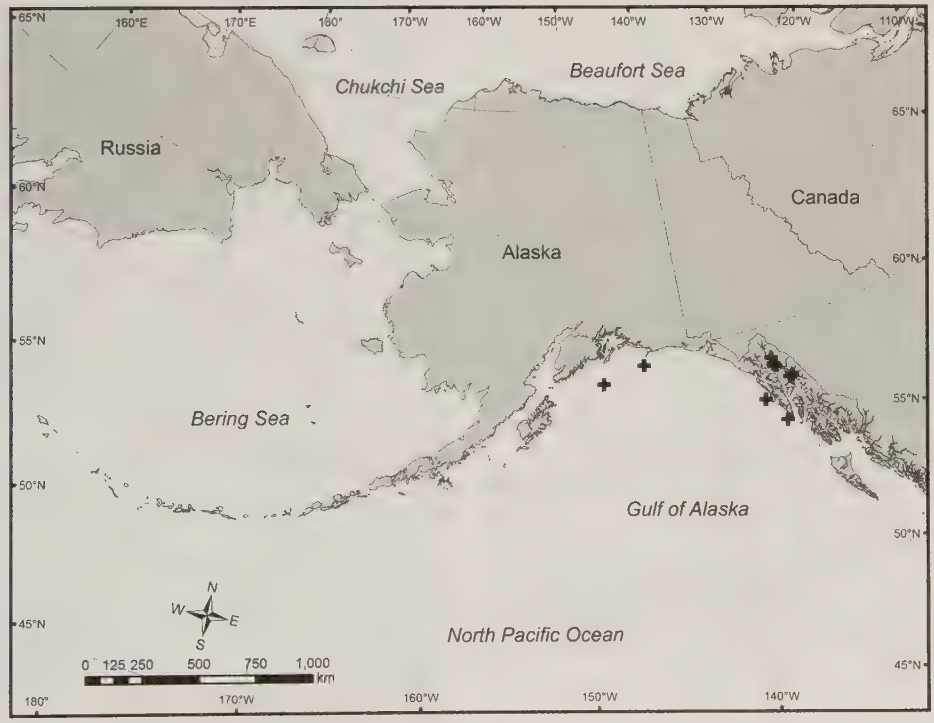
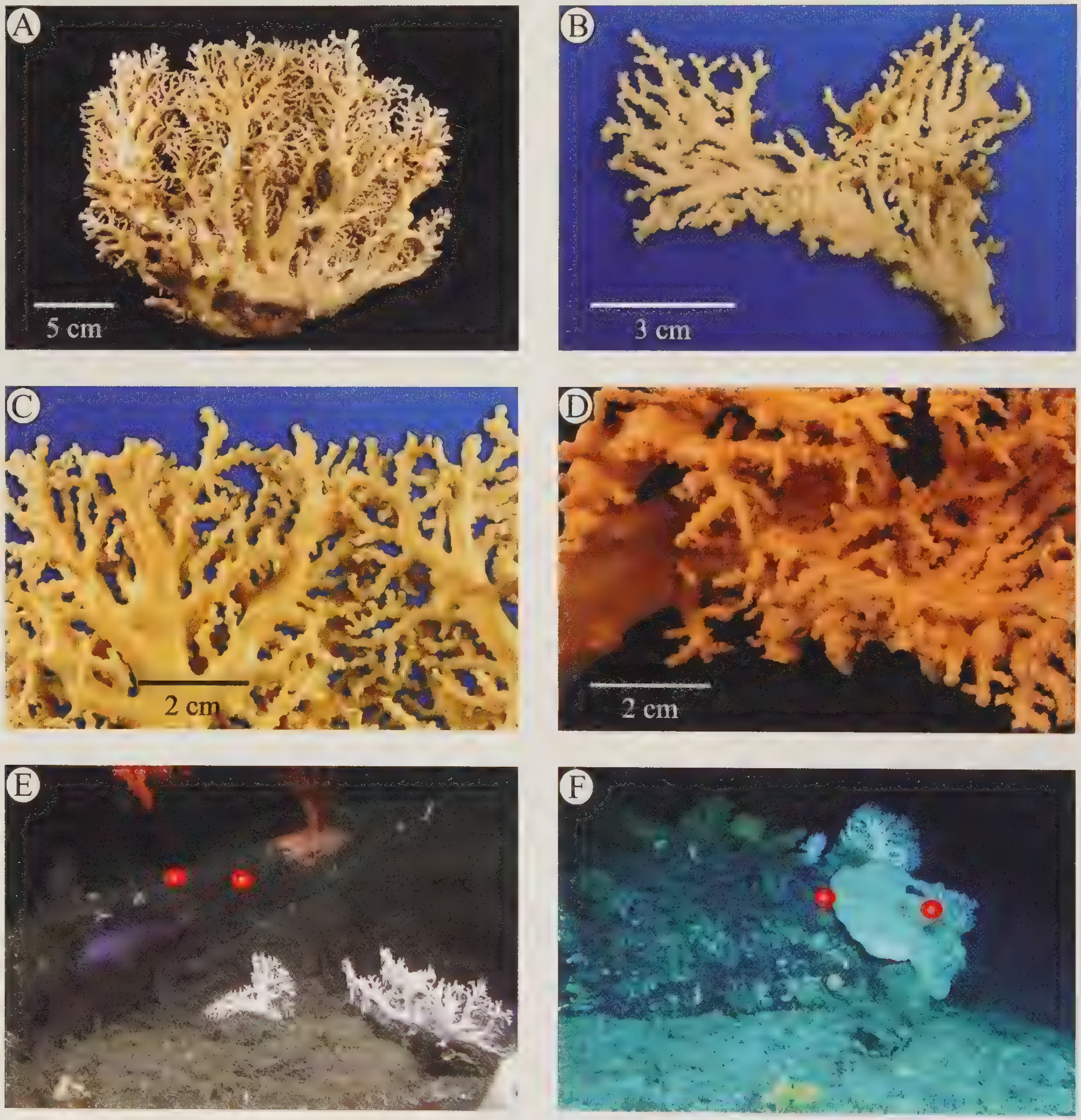


Figure 16-24

A map of the North Pacific Ocean showing the distribution of *Stylaster parageus parageus* (+) in Alaska waters.

rock areas of moderate to strong current, and at depths between 26 and 445 m. Elsewhere – reported at a depth of 23 m.

Photos A) A dried whole *S. p. parageus* colony (USNM 1482020) collected in Stephens Passage, Southeast Alaska, at a depth of 26 m. B) A large portion of a dried *S. p. parageus* colony (USNM 1482021) collected in Stephens Passage at a depth of 35 m. C) A close-up view of the same specimen in photo A. D) A close-up view of the same specimen in photo B. E) A small patch of *S. p. parageus* on the Fairweather Ground, eastern Gulf of Alaska, at a depth of 143 m. F) A small patch of *S. p. parageus* on the Fairweather Ground at a depth of 157 m. The distance between the red lasers marks in photos E and F is 10 cm.



19. *Stylaster repandus* Cairns and Lindner, 2011

Description (Adapted from Cairns and Lindner, 2011) Colonies are firmly attached to hard substrate by a robust stem, which gives rise to several undulating plates that result in a three-dimensional structure. The largest known colony is 23 cm in height and 19 cm in width. The coenosteal texture is reticulate-granular; the coenosteum is light pink and covered with small papillae. Branches are heavily infested with spionid polychaete tubes.

The gastro- and dactylopores are arranged in round cyclosystems on both the faces and edges of plates, and are sometimes arranged in short transverse rows on plate faces. The gastropore tubes are funnel-shaped, each containing a diffuse ring palisade and a short lanceolate gastrostyle. The range of dactylopores per cyclosystem is 1–11 and averages about 4. Diastemas are common, the dactylostyles are robust, and the tall elements are unilinear.

The female ampullae are low swellings on the coenosteum and 0.9–1.1 mm in diameter. The male ampullae are low mounds, primarily internal, and 0.5–0.6 mm in diameter.

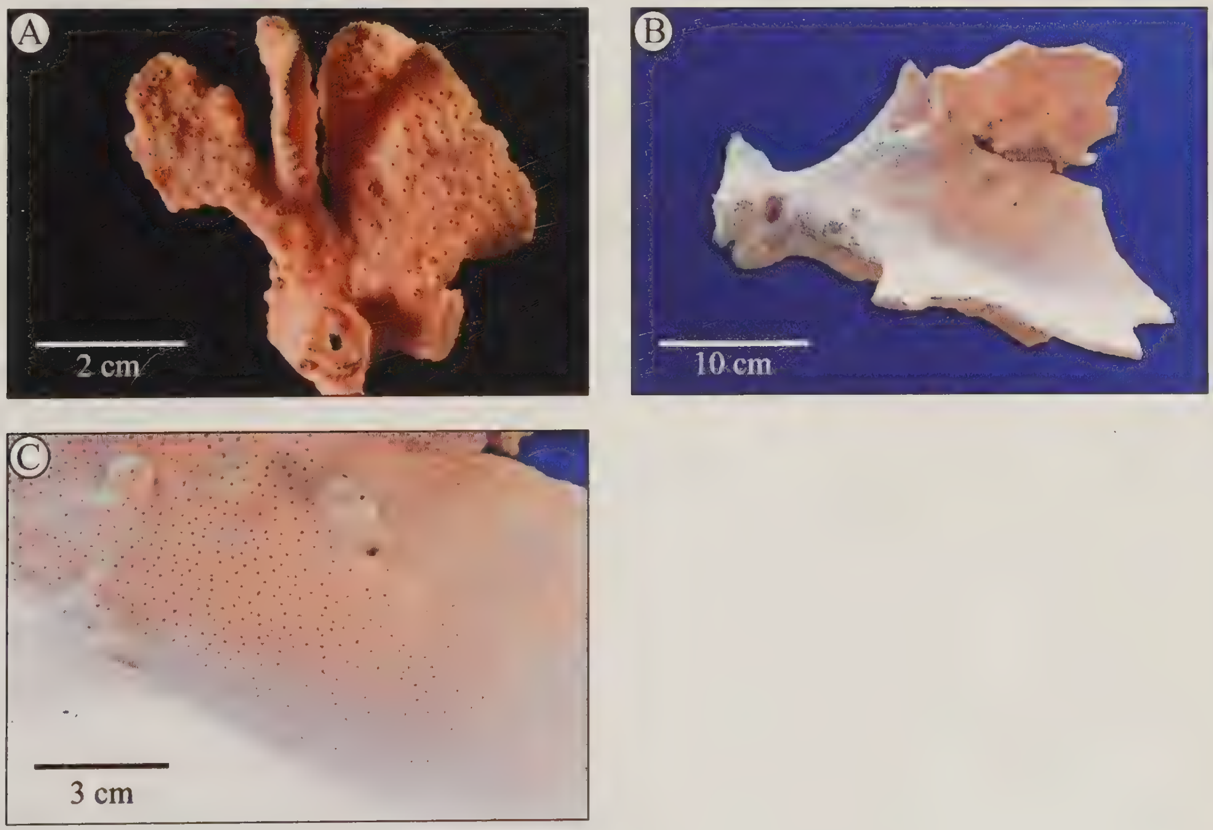
Remarks *Stylaster repandus* is easily distinguished as being the only species of *Stylaster* with a lamellar growth form, but not unlike *Cyclohelia lamellata* and *Errinopora undulata* in this regard.

The coenosteum is composed principally (98%) of high-magnesium calcite (9.7 mol% $MgCO_3$) with very small amounts of aragonite and low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution In Alaska – rare, known from only the four type specimens collected in the same area near Amukta Pass in the eastern Aleutian Islands (Fig. 16-25). It is apparently endemic to the region. Elsewhere – not reported.

Habitat Largely unknown but likely found singly or in small patches on hard rock including bedrock, boulders, cobbles, and pebbles, in areas of moderate current, and at depths between 375 m and about 650 m.

Photos A) A large portion of a dried *S. repandus* colony (USNM 1122741; paratype) collected in Amukta Pass, eastern Aleutian Islands, at a depth of approximately 650 m. B) The dried *S. repandus* holotype (USNM 1122740; large portion of a colony) collected in Amukta Pass at a depth of 375 m. C) A close-up view of the same specimen in photo B.



19. *Stylaster repandus* Cairns and Lindner, 2011 (continued)

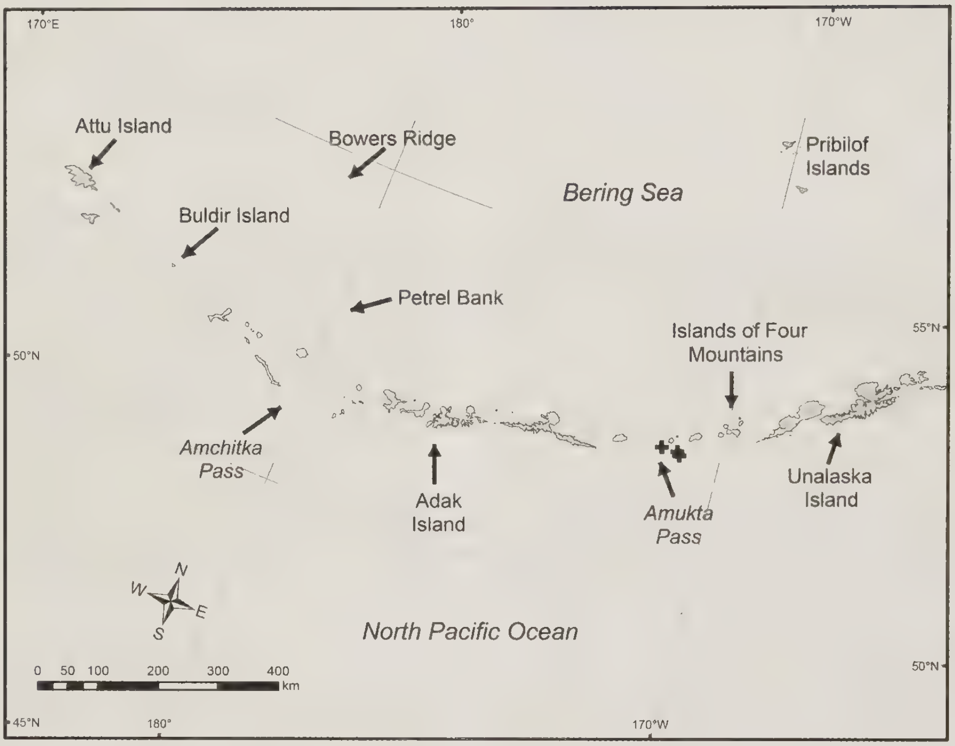

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-25

A map of the Aleutian Islands showing the distribution of *Stylaster repandus* (+) in Alaska waters.

20. *Stylaster stejnegeri* (Fisher, 1938)

Description (Adapted from Cairns and Lindner, 2011) The holotype is an arborescent colony measuring 6 cm in height and 7 cm in width with equal dichotomous branching; the branches are blunt-tipped. The coenosteum is reticulate-granular in texture and is covered with small papillae (possibly nematopores). Binary spionid polychaete tubes are present along the branch axes and the coenosteum is light orange to pink in color.

The gastro- and dactylopores are arranged in cyclosystems that occur uniformly on all sides of branches; the cyclosystems are 1.0–1.2 mm in diameter. The gastropores are circular; the gastropore tubes are cylindrical and slightly curved and each contains a lanceolate gastrostyle but no ring palisade. The range of dactylopores per cyclosystem is 5–11 and averages about 6; dactylostyles are rudimentary. Supernumerary dactylopores are common.

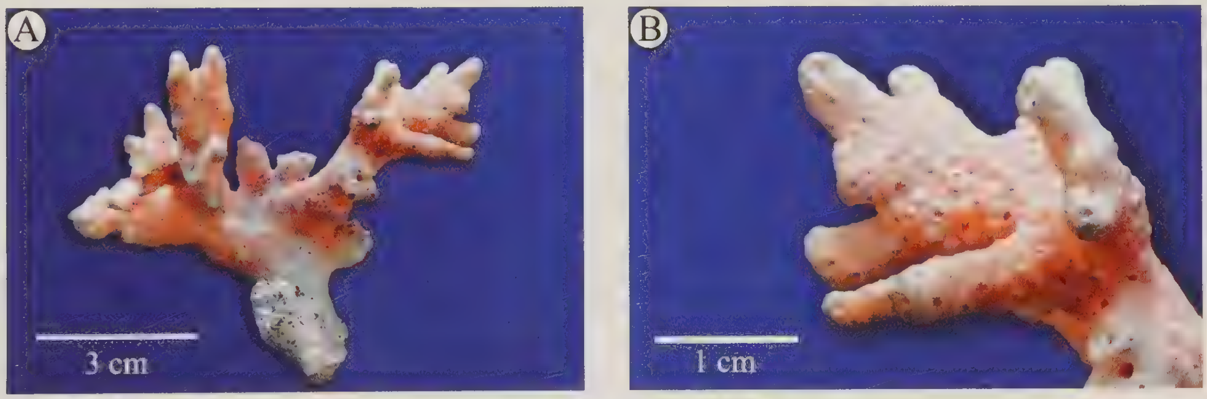
The female ampullae are superficial hemispheres up to 1.1 mm in diameter and are often covered with low radiating ridges. Male ampullae are unknown.

Remarks This species is similar to *S. brochi* but has fewer dactylopores per cyclosystem and ridged female ampullae.

Distribution Extremely rare, known only from the holotype collected on Petrel Bank (Fig. 16-26). It is apparently endemic to the region. Elsewhere – not reported.

Habitat Largely unknown but likely found singly or in small patches on hard rock, including bedrock, boulders, cobbles, and pebbles, in areas of moderate current, and at depths around 95 m.

Photos A) The dried *S. stejnegeri* holotype (USNM 43271; large portion of a colony) collected on Petrel Bank, central Aleutian Islands, at a depth of 87 m. B) A close-up view of the same specimen in photo A.



20. *Stylaster stejnegeri* (Fisher, 1938) (continued)

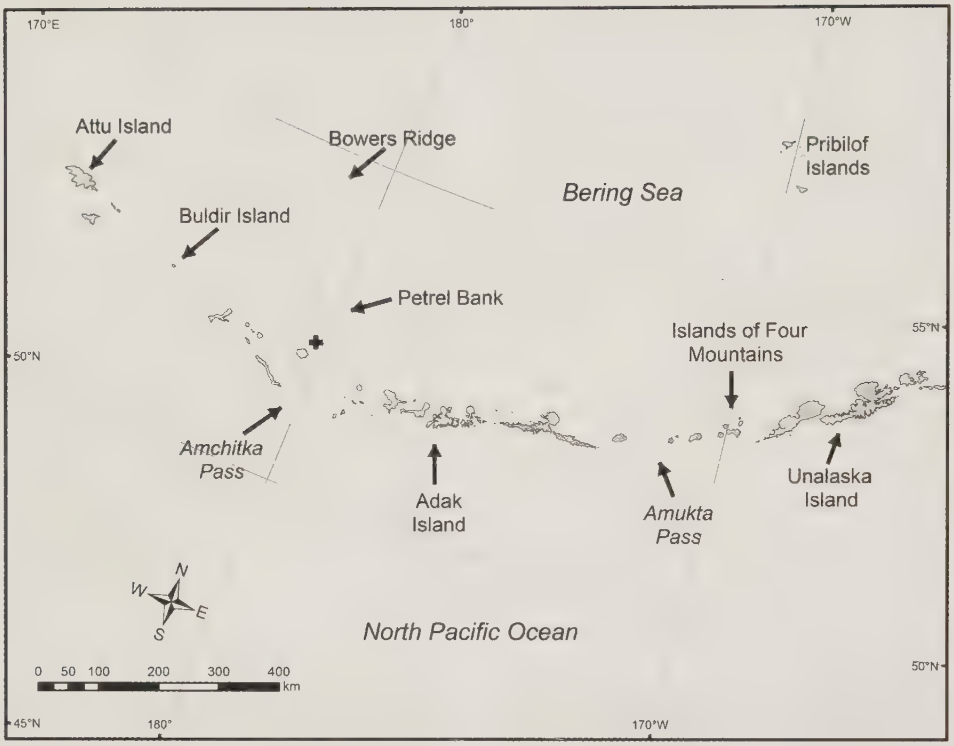

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Petrel Bank
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-26

A map of the Aleutian Islands showing the distribution of *Stylaster stejnegeri* (+) in Alaska waters.

21. *Stylaster trachystomus* (Fisher, 1938)

Description (Adapted from Cairns and Lindner, 2011) Colony branching is uniplanar, in a delicate irregular dichotomous manner; the largest known colony is 12 cm in height and 8 cm in width. The coenosteum is reticulate-granular in texture with short longitudinal ridges present on most branches. The coenosteum is pink-orange in color.

The gastro- and dactylopores are arranged in cyclosystems that occur on all branch faces, with fewer on the posterior face. Cyclosystems are circular to elliptical with the greater axis up to 1.8 mm in length. The gastropore tubes are cylindrical, slightly curved, quite long, and contain a well-developed ring palisade and an elongate lanceolate gastrostyle. The range of dactylopores per cyclosystem is 8–18 and averages about 12; the dactylostyles are inconspicuous.

The female ampullae are superficial hemispheres that measure 1.0–1.3 mm in diameter and often have a knobby or papillose surface. The male ampullae are much smaller (0.50–0.55 mm in diameter) mounds and both types are clustered on anterior branch faces.

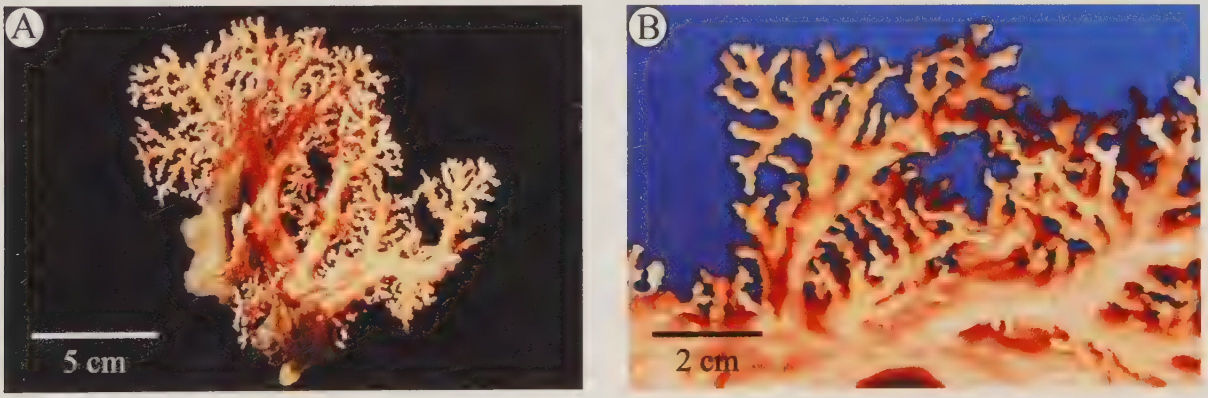
Remarks Originally described as a subspecies of *S. campylecus*, *Stylaster trachystomus* was raised to species level by Cairns and Lindner (2011). This species is similar to *S. campylecus* and *S. brochi*, as discussed by Cairns and Lindner (2011).

The coenosteum is composed almost entirely (89–100%) of aragonite with very small amounts of low-magnesium calcite (Cairns and Macintyre, 1992; senior author and S. D. Cairns, unpubl. data).

Distribution Uncommon (17 specimens total collected). In Alaska – Aleutian Islands (northern Amukta Pass to near Attu Island) including Bowers Ridge (Fig. 16-27). Elsewhere – not reported.

Habitat Typically occurs singly or in small patches on hard rock (bedrock and boulders), in areas of moderate current, and at depths between 110 and 366 m.

Photos A) A whole dried *S. trachystomus* colony (USNM 1481964) collected near the Delarof Islands, central Aleutian Islands, at a depth of 110 m. B) A close-up view of the same specimen in photo A.



21. *Stylaster trachystomus* (Fisher, 1938) (continued)

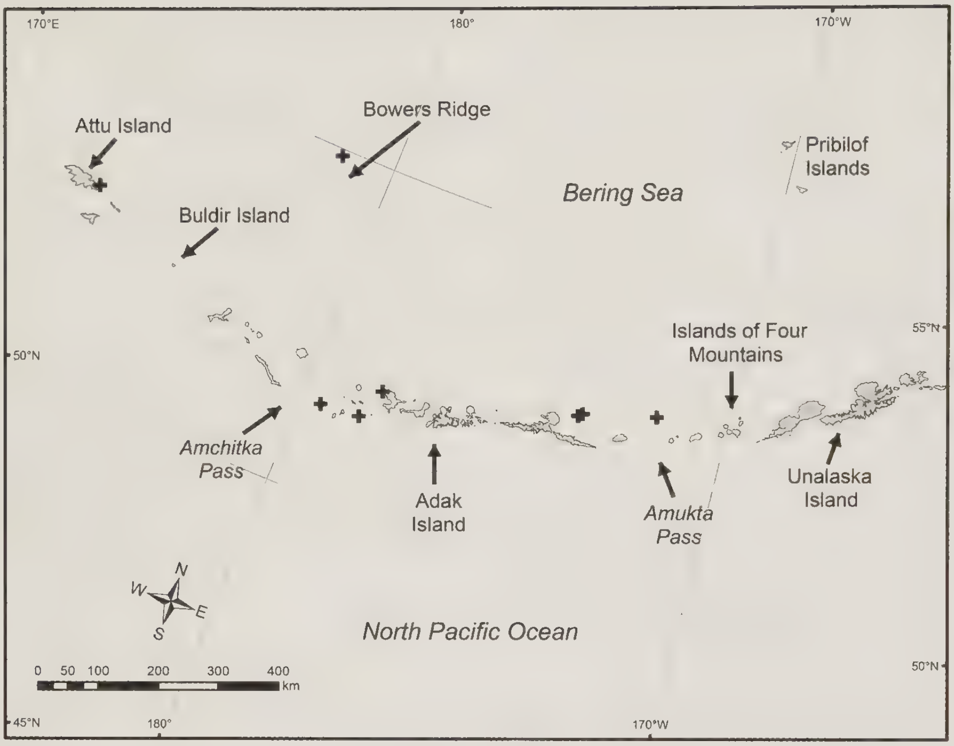

170°E
180°
170°W
Attu Island
Bowers Ridge
Pribilof Islands
Bering Sea
Buldir Island
Islands of Four Mountains
55°N
50°N
Amchitka Pass
Adak Island
Amukta Pass
Unalaska Island
N
W
E
S
North Pacific Ocean
0 50 100 200 300 400 km
50°N
45°N
180°
170°W

Figure 16-27

A map of the Aleutian Islands showing the distribution of *Stylaster trachystomus* (+) in Alaska waters.

22. *Stylaster venustus* (Verrill, 1868)

Description (Adapted from Fisher, 1938) Colonies are small (rarely more than 7 cm in height), planar to bushy, dichotomously branched, and have blunt branch tips. The coenosteum is reticulate-granular in texture and violet or pink in color; coenosteal papillae are common. Internal spionid polychaete tubes are present.

The gastro- and dactylopores are arranged in cyclosystems that occur uniformly on all branch surfaces. The cyclosystems are polygonal and 0.7–0.9 mm in diameter. The gastropore tubes are straight and funnel-shaped, each containing a prominent ring palisade and a lanceolate gastrostyle. The range of dactylopores per cyclosystem is only four to eight and averages about six; the dactylostyles are robust.

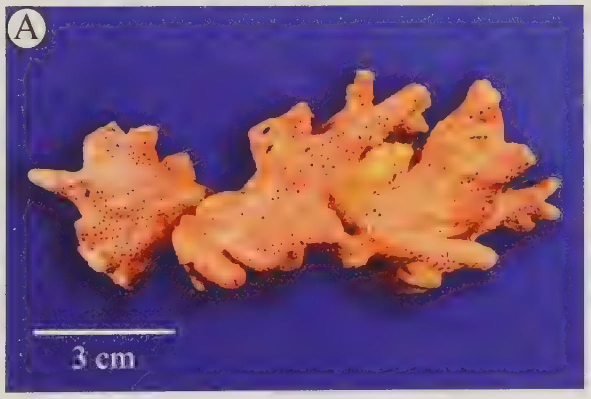
The female ampullae are entirely internal and about 0.6 mm in diameter. The male ampullae are also internal, quite abundant, and about 0.40 mm in diameter.

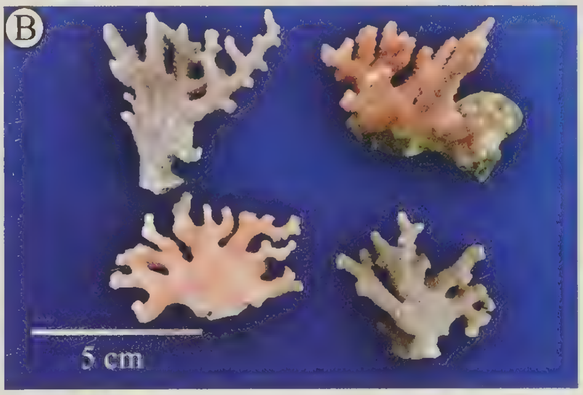
Remarks *Stylaster venustus* is most similar to *S. verrillii* (Dall, 1884), but has larger cyclosystems, smaller branches, and differs in the color of the coenosteum (see Cairns and Lindner, 2011, p. 48, table 2, figure 16). The coenosteum is composed almost entirely (96%) of aragonite with very small amounts of low-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Rare. In Alaska – known from only a single specimen collected near Cape Ommaney, Baranof Island, in the eastern Gulf of Alaska (Fig. 16-28). This specimen (see photo A) represents the northernmost record for the species. Elsewhere – British Columbia to central California (Big Sur).

Habitat In Alaska – largely unknown but likely found in small patches on hard rock, including bedrock, boulders, cobbles, and pebbles, in areas of moderate current and tidal surge, and at shallow depths (around 20 m). Elsewhere – specimens have been collected at depths between 4 m (southern British Columbia) and 117 m (Heceta Bank, off Oregon).

Photos A) Portions of dried *S. venustus* colonies (USNM 1482062) collected near Cape Ommaney, Baranof Island, eastern Gulf of Alaska, at a depth of 20 m. B) Four whole dried *S. venustus* colonies (USNM 76544) collected in the Strait of Juan de Fuca, Washington, at a depth of 73 m.





22. *Stylaster venustus* (Verrill, 1868) (continued)

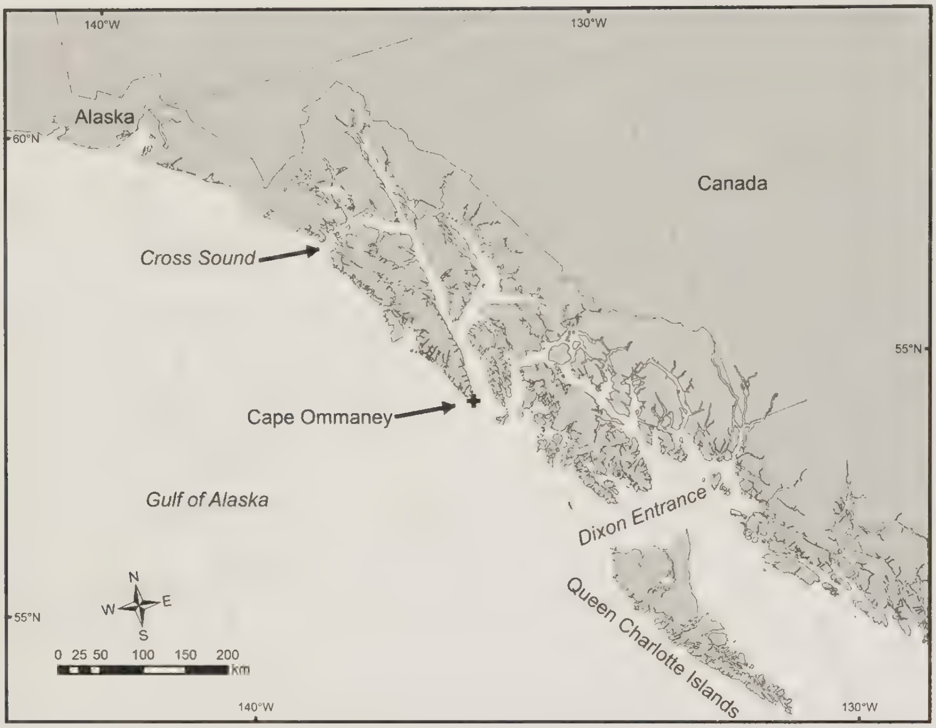

140°W
130°W
Alaska
60°N
Canada
Cross Sound
55°N
Cape Ommaney
Gulf of Alaska
Dixon Entrance
Queen Charlotte Islands
N
W
E
S
55°N
0 25 50 100 150 200
km
140°W
130°W

Figure 16-28

A map of the eastern Gulf of Alaska showing the distribution of *Stylaster venustus* (+) in Alaska waters.

23. *Stylaster verrillii* (Dall, 1884)

Description (Adapted from Cairns and Lindner, 2011) Colonies are arborescent and dichotomously branched; the branches have blunt to clavate tips. The largest known colony is only 3.5 cm in height and 7 cm in width. The coenosteum is reticulate-granular in texture and coenosteal papillae are common. Spionid polychaete worm tubes are also common. The coenosteum is light orange to bright pink in color.

The gastro- and dactylopores are arranged in cyclosystems that occur uniformly on all branch surfaces; the cyclosystems are round and 1.0–1.2 mm in diameter. The gastropore tubes are elongate and cylindrical, and each contains a well-developed ring palisade and an elongate spiny gastrostyle. The range of dactylopores per cyclosystem is 5–10 and averages about 7; the dactylostyles are robust.

The female ampullae are internal and 0.7–0.8 mm in diameter. The male ampullae are also internal and 0.3–0.5 mm in diameter.

Remarks This species was originally described as *Allopora moseleyi* Dall, 1884. It is most similar to *S. venustus* and compared to that species in the account of that species above. The reproductive ecology of this species has been studied from colonies collected in the Aleutian Islands (Brooke and Stone, 2007).

The skeleton (coenosteum) is composed principally (96.2–99.7%) of high-magnesium calcite (9.0–9.4 mol% $MgCO_3$) with very small amounts of aragonite and low- and high-magnesium calcite (senior author and S. D. Cairns, unpubl. data).

Distribution Common, abundant in some areas. In Alaska – this species exhibits an apparent disjunct distribution in Alaska. Collected from the eastern Gulf of Alaska including the inside waters of Southeast Alaska to northwest of Portlock Bank in the western Gulf of Alaska and the Aleutian Islands (Akutan Pass to near Kiska Island; Fig. 16-29). Elsewhere – northern British Columbia near the border with Southeast Alaska to the San Juan Islands of Washington. There is a single record from the Sea of Okhotsk, Russia.

Habitat In Alaska – typically occurs in patches, sometimes dense, on rocky bedrock pinnacles and other hard rock, including cobbles and pebbles, in areas of moderate

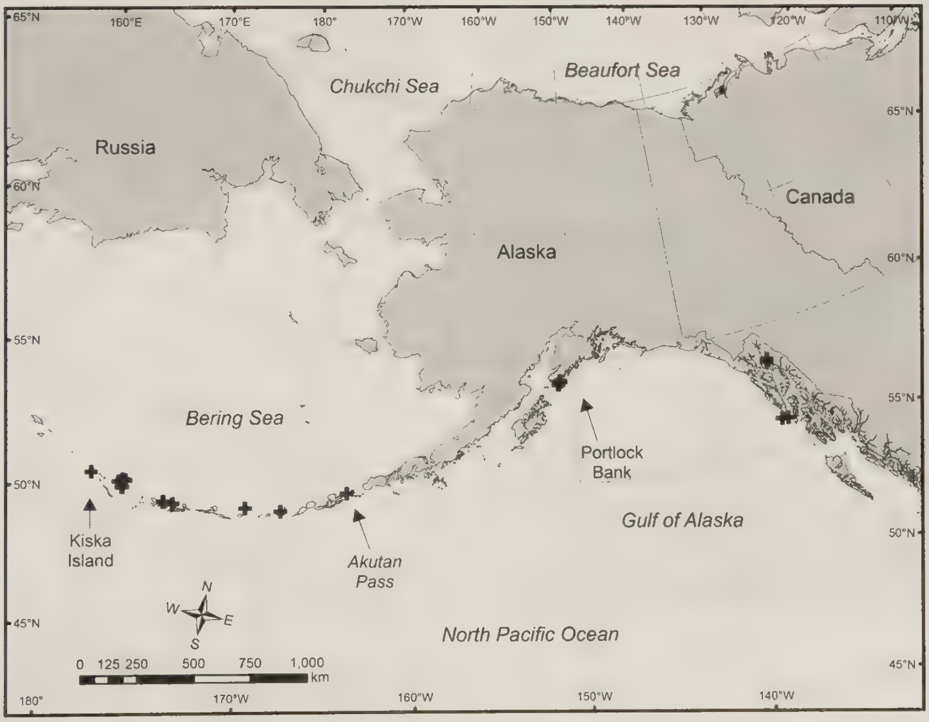
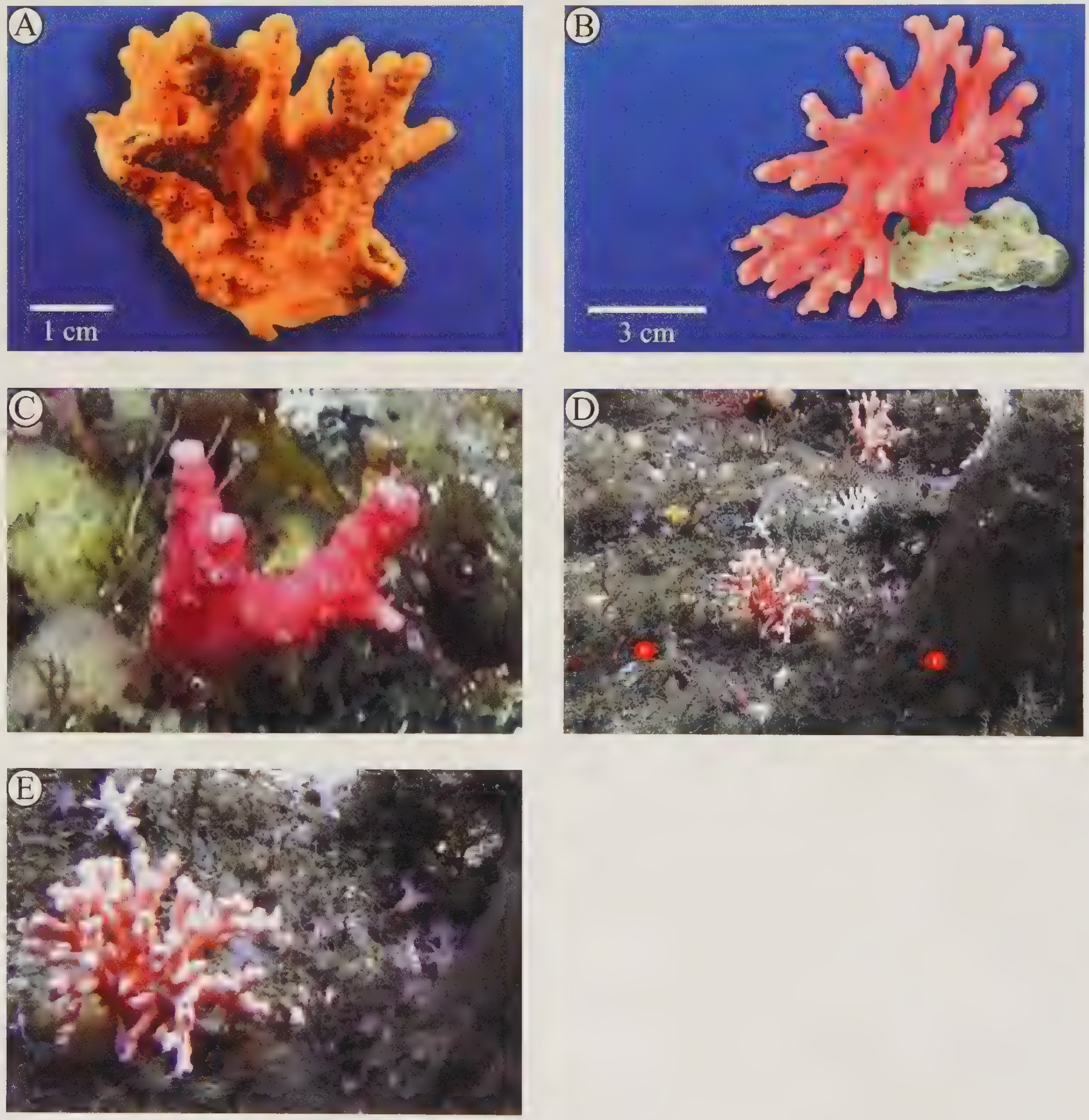

65°N
160°E
170°E
180°
170°W
160°W
150°W
140°W
130°W
120°W
110°W
Beaufort Sea
Chukchi Sea
Russia
65°N
60°N
Canada
Alaska
60°N
55°N
Bering Sea
55°N
Portlock Bank
50°N
Gulf of Alaska
50°N
Kiska Island
Akutan Pass
N
W
E
S
45°N
North Pacific Ocean
45°N
0 125 250 500 750 1,000 km
180°
170°W
160°W
150°W
140°W

Figure 16-29

A map of the North Pacific Ocean showing the distribution of *Stylaster verrillii* (+) in Alaska waters.

to strong current, and at depths between 11 and 401 m. Elsewhere – reported at depths between 23 and 183 m.

Photos A) A dried whole *S. verrillii* colony (USNM 1482150) collected near Bobrof Island, central Aleutian Islands, at a depth of 17 m. B) A dried whole *S. verrillii* colony (USNM 1027819) collected near Cape Moffet, Adak Island, central Aleutian Islands, at a depth of 155 m. C) A *S. verrillii* colony photographed on Shutter Ridge, eastern Gulf of Alaska, at a depth of 88 m. D) A small patch of *S. verrillii* photographed on Shutter Ridge at a depth of 143 m. The distance between the red laser marks is 10 cm. E) A close-up view of one colony in photo D.



Acknowledgments

We thank J. Heard for preparing hundreds of photographs for this publication and B. Wing, C. O'Clair, J. Karinen, D. Carlson, S. France, L. Watling, K. Iken, P. Etnoyer, A. Baco-Taylor, T. Marshall, K. Lowyck, J. Hocevar, M. Ridgway, and countless others for assistance with the collection of specimens. F. Sinniger Harii contributed substantially to the Zoantharia chapter; J. Thoma, B. Horvath, and M. Everett shared taxonomic insights; and A. Helbling and A. Cohen provided laboratory analyses on calcium carbonate mineralogy. D. Csepp, T. Warshaw, D. Harris, N. McDaniel, M. Chamberlain, L. Barr, P. Malecha, D. Geiger, and R. Langton provided in situ, topside, and laboratory photographs. Specimen metadata and laboratory assistance were provided by J. Orr, M. Boyd, C. Piotrowski, G. Hendler, E. Kools, L. Lundsten, B. Voss, G. Keel, H. Gartner, A. Mickle, S. McCue, and V. Delnavaz. We thank Cara Mayo and Shelley Arenas for skillful editing and publication advice and two anonymous referees for helpful reviews of the manuscript. Field collections were supported by NOAA Fisheries (Alaska Fisheries Science Center), NOAA Undersea Research Program (West Coast and Polar Regions Undersea Research Center), NOAA Ocean Exploration, the North Pacific Research Board, and Greenpeace International. Funding for the publication of this guide was provided by NOAA's Alaska Fisheries Science Center and Deep Sea Coral Research and Technology Program.

Literature cited

Andrews, A. H., E. E. Cordes, M. M. Mahoney, K. Munk, K. H. Coale, G. M. Cailliet, and J. Heifetz.

2002. Age, growth and radiometric age validation of a deep-sea, habitat-forming gorgonian (*Primnoa resedaeformis*) from the Gulf of Alaska. Hydrobiologia 471:101–110. https://doi.org/10.1023/A:1016501320206

Andrews, A. H., G. M. Cailliet, L. A. Kerr, K. H. Coale, C. Lundstrom, and A. P. DeVogelaere.

2005. Investigations of age and growth for three deep-sea corals from the Davidson Seamount off central California. *In* Cold-water corals and ecosystems (A. Freiwald and J. M. Roberts, eds.), p. 1021–1038. Springer-Verlag, Berlin, Germany.

Andrews, A. H., R. P. Stone, C. C. Lundstrom, and A. P. DeVogelaere.

2009. Growth rate and age determination of bamboo corals from the northeastern Pacific Ocean using refined ^{210}Pb dating. Mar. Ecol. Prog. Ser. 397:173–185. https://doi.org/10.3354/meps08193

Aranha, R.

2010. Geochemistry, microstructure and growth banding in *Stylaster campylecus parageus* and *Primnoa pacifica*: implications for commonly observed deep sea corals as paleoceanographic archives. M.S. thesis, 264 p. Meml. Univ. Nfld., St. John's, NL, Canada. [Available from http://research.library.mun.ca/id/eprint/9617.]

Aranha, R., E. Edinger, G. Layne, and G. Piercey.

2014. Growth rate variation and potential paleoceanographic proxies in *Primnoa pacifica*: insights from high-resolution trace element microanalysis. Deep-Sea Res., II 99:213–226. https://doi.org/10.1016/j.dsr1012.2013.1007.1001

Ardila, N. E., G. Giribet, and J. A. Sánchez.

2012. A time-calibrated molecular phylogeny of the precious corals: reconciling discrepancies in the taxonomic classification and insights into their evolutionary history. BMC Evol. Biol. 12:246. https://doi.org/10.1186/1471-2148-12-246

Aurivillius, M.

1931. The gorgonarians from Dr. Sixten Bock's expedition to Japan and Bonin Islands 1914. Kungliga Svenska VetenskapsAkademiens Handlingar, Tredje Serien 9:1–337.

Baco, A. R.

2007. Exploration for deep-sea corals on North Pacific seamounts and islands. Oceanography 20:108–117. https://doi.org/10.5670/oceanog.2007.11

Baco, A. R., and T. M. Shank.

2005. Population genetic structure of the Hawaiian precious coral *Corallium lauuense* (Octocorallia: Coralliidae) using microsatellites. *In* Cold-water corals and ecosystems (A. Freiwald and J. M. Roberts, eds.), p. 663–678. Springer-Verlag, Berlin, Germany.

Barr, L., and N. Barr.

1983. Under Alaskan seas: the shallow water marine invertebrates, 208 p. Alsk. Northwest Publ. Co., Anchorage, AK.

Bayer, F. M.

1952a. Descriptions and redescriptions of the Hawaiian octocorals collected by the U. S. Fish Commission Steamer "Albatross." (1. Alcyonacea, Stolonifera, and Telestacea). Pac. Sci. 4:126–136.

1952b. Two new species of *Arthrogorgia* (Gorgonacea: Primnoidae) from the Aleutian Islands region. Proc. Biol. Soc. Wash. 65:63–70.

1956. Descriptions and redescriptions of the Hawaiian octocorals collected by the U. S. Fish Commission steamer "Albatross" (2. Gorgonacea: Scleraxonia). Pac. Sci. 10:67–95.

1981. Key to the genera of Octocorallia exclusive of Pennatulacea (Coelenterata: Anthozoa), with diagnoses of new taxa. Proc. Biol. Soc. Wash. 94:902–947.

1990. A new isidid octocoral (Anthozoa: Gorgonacea) from New Caledonia, with descriptions of other new species from elsewhere in the Pacific Ocean. Proc. Biol. Soc. Wash. 103:205–228.

1996. The gorgonacean genus *Arthrogorgia* (Octocorallia: Primnoidae). Proc. Biol. Soc. Wash. 109:605–628.

Bayer, F. M., and J. Stefani.

1987. New and previously known taxa of isidid octocorals (Coelenterata: Gorgonacea), partly from Antarctic waters. Proc. Biol. Soc. Wash. 100:937–991.

Bayer, F. M., M. Grasshoff, and J. Verseveldt.

1983. Illustrated trilingual glossary of morphological and anatomical terms applied to Octocorallia, 75 p. E. J. Brill, Leiden, Netherlands.

Boutillier, P. D. G., J. A. Boutillier, and G. E. Gillespie.

2019. British Columbia corals: a synopsis of information on their taxonomy, occurrences, distribution, threats and general status. Can. Tech. Rep. Fish. Aquat. Sci. 3322, 260 p.

Bramanti, L., G. Magagnini, L. De Maio, and G. Santangelo.

2005. Recruitment, early survival and growth of the Mediterranean red coral *Corallium rubrum* (L. 1758), a 4-year study. J. Exp. Mar. Biol. Ecol. 314:69–78. https://doi.org/10.1016/j.jembe.2004.08.029

Breedy, O., S. D. Cairns, and V. Häussermann.

2015. A new alcyonacean octocoral (Cnidaria, Anthozoa, Octocorallia) from Chilean fjords. Zootaxa 3919:327–334. https://doi.org/10.11646/zootaxa.3919.2.5

Broch, H.

1932. Über einige geographisch interessante Fundstellen von Alcyonarien und Hydrokorallen im nördlichen Stillen Ozean. Explor. Mers U. R. S. S., Leningrad 17:81–86.

1935. Oktokorallen des Nördlichsten Pazifischen Ozeans und ihre Beziehungen zur Atlantischen Fauna. Avhandlinger utgitt av det Norske Videnskaps-Akaademi 1935(1):1–53.

1957. The northern octocoral, *Paragorgia arborea* (L.), in sub-Antarctic waters. Nature 179:1356. https://doi.org/10.1038/1791356a0

Brodeur, R. D.

2001. Habitat-specific distribution of Pacific ocean perch (*Sebastes alutus*) in Pribilof Canyon, Bering Sea. Cont. Shelf Res. 21:207–224. https://doi.org/10.1016/S0278-4343(00)00083-2

Brook, G.

1889. Report on the Antipatharia collected by H.M.S. *Challenger* during the years 1873–76. *In* Report on the scientific results of the voyage of the H.M.S. *Challenger* during the years 1873–76. Zoology, vol. 32, part 80, p. 1–222. Neill and Co., Edinburgh, Scotland.

Brooke, S., and R. P. Stone.

2007. Reproduction of deep-water hydrocorals (family

Stylasteridae) from the Aleutian Islands, Alaska. Bull. Mar. Sci. 81:519–532.

Busby, M. S., J. W. Orr, and D. M. Blood.
2006. Eggs and late-stage embryos of *Allocareproctus unangas* (family Liparidae) from the Aleutian Islands. Ichthyol. Res. 53:423–426. https://doi.org/10.1007/s10228-006-0361-3

Cairns, S. D.
1981. Marine flora and fauna of the northeastern United States. Scleractinia. NOAA Tech. Rep. NMFS Circ. 438, 14 p.
1982. Antarctic and Subantarctic Scleractinia. Antarct. Res. Ser. 34, 74 p.
1991. *Cyclohelia lamellata*, new genus and species of Stylasteridae (Cnidaria: Hydrozoa) from the Bering Sea. Pac. Sci. 45:383–388.
1994. Scleractinia of the temperate North Pacific. Smithson. Contrib. Zool. 557, 150 p.
1995. The marine fauna of New Zealand: Scleractinia (Cnidaria: Anthozoa). N. Z. Oceanogr. Inst. Mem. 103, 139 p.
2001. Studies on western Atlantic Octocorallia (Coelenterata: Anthozoa). Part 1. The genus *Chrysogorgia* Duchassaing and Michelotti, 1864. Proc. Biol. Soc. Wash. 114:746–787.
2004. A new shallow-water species of *Javania* (Scleractinia: Flabellidae) from Indonesia. Raffles Bull. Zool. 52:7–10.
2007. Calcaxonian octocorals (Cnidaria: Anthozoa) from the Eastern Pacific seamounts. Proc. Calif. Acad. Sci. 58:511–541.
2010. A review of the Octocorallia (Cnidaria: Anthozoa) from Hawai'i and adjacent seamounts. Part 3: genera *Thouarella, Plumarella, Callogorgia, Fanellia*, and *Parastenella*. Pac. Sci. 64:413–440. https://doi.org/10.2984/64.3.413
2011a. A revision of the Primnoidae (Octocorallia: Alcyonacea) from the Aleutian Islands and Bering Sea. Smithson. Contrib. Zool. 634, 55 p.
2011b. Global diversity of the Stylasteridae (Cnidaria: Hydrozoa: Anthecatae). PLoS ONE 6(7):e21670. https://doi.org/10.1371/journal.pone.0021670
2015. Tropical deep-sea benthos volume 28: Stylasteridae (Cnidaria: Hydrozoa: Anthoathecata) of the New Caledonian region. Mem. Mus. Natl. Hist. Nat., Paris 207, 362 p.
2016. The marine fauna of New Zealand: primnoid octocorals (Anthozoa, Alcyonacea) — Part 2. *Primnoella*, *Callozostron*, *Metafannyella*, *Callogorgia*, *Fanellia* and other genera. NIWA Biodivers. Mem. 129, 131 p.
2018. Deep-water octocorals (Cnidaria, Anthozoa) from the Galápagos and Cocos Islands. Part 1. Suborder Calcaxonia. ZooKeys 729:1–46. https://doi.org/10.3897/zookeys.729.21779
2021. The marine fauna of New Zealand: primnoid octocorals (Anthozoa, Alcyonacea) — Part 3. *Thouarella*, and additional records of other primnoid species. NIWA Biodivers. Mem. 133, 67 p.

Cairns, S. D., and A. Baco.
2007. Review and five new Alaskan species of the deep-water octocoral *Narella* (Octocorallia: Primnoidae). Syst. Biodivers. 5:391–407. https://doi.org/10.1017/s1477200007002472

Cairns, S. D., and F. M. Bayer.
2005. A review of the genus *Primnoa* (Octocorallia: Gorgonacea: Primnoidae), with the description of two new species. Bull. Mar. Sci. 77:225–256.
2009. A generic revision and phylogenetic analysis of the Primnoidae (Cnidaria: Octocorallia). Smithson. Contrib. Zool. 629, 79 p.

Cairns, S. D., and M. V. Kitahara.
2012. An illustrated key to the genera and subgenera of the Recent azooxanthellate Scleractinia (Cnidaria, Anthozoa), with an attached glossary. ZooKeys 227:1–47. https://doi.org/10.3897/zookeys.227.3612

Cairns, S. D., and A. Lindner.
2011. A revision of the Stylasteridae (Cnidaria, Hydrozoa, Filifera) from Alaska and adjacent waters. ZooKeys 158:1–88. https://doi.org/10.3897/zookeys.158.1910

Cairns, S. D., and I. G. Macintyre.
1992. Phylogenetic implications of the calcium carbonate mineralogy in the Stylasteridae (Cnidaria: Hydrozoa). Palaios 7:96–107. https://doi.org/10.2307/3514799

Cairns, S. D., and M. L. Taylor.
2019. An illustrated key to the species of the genus *Narella* (Cnidaria, Octocorallia, Primnoidae). ZooKeys 822:1–15. https://doi.org/10.3897/zookeys.822.29922

Cairns, S. D., and H. H. Wirshing.
2018. A phylogenetic analysis of the Primnoidae (Anthozoa: Octocorallia: Calcaxonia) with analyses of character evolution and a key to the genera and subgenera. BMC Evol. Biol. 18:66. https://doi.org/10.1186/s12862-018-1182-5

Cairns, S. D., R. P. Stone, H.-W. Moon, and J. H. Lee.
2018. Primnoidae (Octocorallia: Calcaxonia) from the Emperor Seamounts, with Notes on *Callogorgia elegans* (Gray, 1870). Pac. Sci. 72:125–142. https://doi.org/10.2984/72.1.8

Cairns, S. D., R. T. S. Cordeiro, Y. Xu, Z. Zhan, and P. A. Alderslade.
2021. A new family and two new genera of calcaxonian octocoral, including a redescription of *Pleurogorgia militaris* (Cnidaria: Octocorallia: Chrysogorgiidae) and its placement in a new genus. Invert. Syst. 35:282–297. https://doi.org/10.1071/IS20066

Chaytor, J. D., R. A. Keller, R. A. Duncan, and R. P. Dziak.
2007. Seamount morphology in the Bowie and Cobb hotspot trails, Gulf of Alaska. Geochem. Geophys. Geosyst. 8:Q09016. https://doi.org/10.1029/2007GC001712

Choy, E., K. Watanabe, B. Williams, R. Stone, P. Etnoyer, E. Druffel, T. Lorenson, and M. Knaak.
2020. Understanding growth and age of red tree corals (*Primnoa pacifica*) in the North Pacific Ocean. PLoS ONE 15(12):e0241692. https://doi.org/10.1371/journal.pone.0241692

CITES (Convention on International Trade in Endangered Species).
2007. Convention on international trade in endangered species of wild fauna and flora. Consideration of proposals for amendment of appendices I and II. Fourteenth meeting of the conference of the parties. The Hague (Netherlands), 3–15 June, CoP14 prop. 21, 22 p. [Available from https://cites.org/sites/default/files/eng/cop/14/prop/E14-P21.pdf.]

Cordeiro, R. T. S., S. D. Cairns, and C. D. Pérez.
2017. A revision of the genus *Radicipes* Stearns,1883 (Anthozoa: Octocorallia: Chrysogorgiidae). Zootaxa 4319:1–26. https://doi.org/10.11646/zootaxa.4319.1.1

Cordes, E. E., J. W. Nybakken, and G. Van Dykhuizen.
2001. Reproduction and growth of *Anthomastus ritteri* (Octocorallia: Alcyonacea) from Monterey Bay, California,

USA. Mar. Biol. 138:491–501. https://doi.org/10.1007/s002270000470

Cutress, C. E., and W. E. Pequegnat.
1960. Three new species of Zoantharia from California. Pac. Sci. 14:89–100.

Dall, W. H.
1884. On some Hydrocorallinae from Alaska and California. Proc. Biol. Soc. Wash. 2:111–115.

Daly, M., M. R. Brugler, P. Cartwright, A. G. Collins, M. N. Dawson, D. G. Fautin, S. C. France, C. S. McFadden, D. M. Opresko, E. Rodriguez, et al.
2007. A review of phylogenetic patterns and diversity 300 years after Linnaeus. Zootaxa 1668:127–182. https://doi.org/10.11646/zootaxa.1668.1.11

Danielssen, D. C.
1860. Beskrivelse over en ny Art Virgularia [meeting report]. Forhandlinger i Videnskabs-selskabet i Christiania. 1859, 251 p.

Dautova, T. N.
2007. Gorgonians (Anthozoa: Octocorallia) of the northwestern Sea of Japan. Russ. J. Mar. Biol. 33:297–304. https://doi.org/10.1134/S1063074007050045
2018. Two new species of deep-water *Calcigorgia* gorgonians (Anthozoa: Octocorallia) from the Kurile Islands, Sea of Okhotsk, with a review of the distinctive characters of the known species of the genus. Eur. J. Taxon. 408:1–22. https://doi.org/10.5852/ejt.2018.408

Desonie, D. L., and R. A. Duncan.
1990. The Cobb-Eikelberg seamount chain: hotspot volcanism with mid-ocean ridge basalt affinity. J. Geophys. Res. 95:12697–12711. https://doi.org/10.1029/JB095iB08p12697

Dolan, E.
2008. Phylogenetics, systematics and biogeography of deep-sea Pennatulacea (Anthozoa: Octocorallia): evidence from molecules and morphology. Ph.D. diss., 195 p. Univ. Southampton, Southampton, UK. [Available from https://eprints.soton.ac.uk/65669/.]

Duchassaing, P., and J. Michelotti.
1864. Supplément au mémoire sur les coralliaires des Antilles, ser. 2, vol. 23, 112 p. Mém. Acad. Sci. Turin (2)23:97–206.

Dueñas, L. F., P. Alderslade, and J. A. Sánchez.
2014. Molecular systematics of the deep-sea bamboo corals (Octocorallia: Isididae: Keratoisidinae) from New Zealand with descriptions of two new species of *Keratoisis*. Mol. Phylogenet. Evol. 74:15–28. https://doi.org/10.1016/j.ympev.2014.01.031

Du Preez, C., and V. Tunnicliffe.
2011. Shortspine thornyhead and rockfish (Scorpaenidae) distribution in response to substratum, biogenic structures and trawling. Mar. Ecol. Prog. Ser. 425:217–231. https://doi.org/10.3354/meps09005

Durham, J. W.
1947. Corals from the Gulf of California and the North Pacific coast of America. Geol. Soc. Am. Mem. 20, 68 p.

Durham, J. W., and J. L. Barnard.
1952. Stony corals of the eastern Pacific collected by the *Velero III* and *Velero IV*. Allan Hancock Pac. Exped. 16, 110 p.

Eckelbarger, K. J., P. A. Taylor, and R. W. Langton.
1998. Gonadal morphology and gametogenesis in the sea pen *Pennatula aculeata* (Anthozoa: Pennatulacea) from the Gulf of Maine. Mar. Biol. 132:677–690. https://doi.org/10.1007/s002270050432

Ehrenberg, C. G.
1834. Beiträge zur physiologischen Kenntniss der Corallenthiere im allgemeinen, und besonders des rothen Meeres, nebst einem Versuche zur physiologischen Systematik derselben. Abh. Königlichen Akad. Wiss., Berlin. 1:225–380.

Esper, E. J. C.
1794. Fortsetzungen der Pflanenthiere, vol. 1, parts 1–2, 64 p., Nürnberg.

Etnoyer, P. J.
2008. A new species of *Isidella* bamboo coral (Octocorallia: Alcyonacea: Isididae) from northeast Pacific seamounts. Proc. Biol. Soc. Wash. 121:541–553. https://doi.org/10.2988/08-16.1

Etnoyer, P., S. D. Cairns, J. A. Sanchez, J. K. Reed, J. V. Lopez, W. W. Schroeder, S. D. Brooke, L. Watling, A. Baco-Taylor, G. C. Williams, et al.
2006. Deep-sea coral collection protocols. NOAA Tech. Memo. NMFS-OPR-28, 53 p.

Everett, M. V., L. K. Park, E. A. Berntson, A. E. Elz, C. E. Whitmire, A. A. Keller, and M. E. Clarke.
2016. Large-scale genotyping-by-sequencing indicates high levels of gene flow in the deep-sea octocoral *Swiftia simplex* (Nutting 1909) on the West Coast of the United States PLoS ONE 11(10):e0165279. https://doi.org/10.1371/journal.pone.0165279

Fabricius, K., and P. Alderslade.
2001. Soft corals and sea fans: a comprehensive guide to the tropical shallow-water genera of the central-west Pacific, the Indian Ocean and the Red Sea, 264 p. Aust. Inst. Mar. Sci., Townsville, Australia.

Feehan, K. A., and R. G. Waller.
2015. Notes on reproduction of eight species of Eastern Pacific cold-water octocorals. J. Mar. Biol. Assoc. UK 95(4):691–696. https://doi.org/10.1017/S0025315415000053

Fisher, W. K.
1931. Californian hydrocorals. Ann. Mag. Nat. Hist., ser. 10, 8(46):391–399.
1938. Hydrocorals of the North Pacific Ocean. Proc. U. S. Natl. Mus. 84:493–554. https://doi.org/10.5479/si.00963801.84-3024.493

Flint, H. C., R. G. Waller, and P. A. Tyler.
2007. Reproductive ecology of *Fungiacyathus marenzelleri* from 4100 m depth in the northeast Pacific Ocean. Mar. Biol. 151:843–849. https://doi.org/10.1007/s00227-006-0539-2

Försterra, G., and V. Häussermann.
2003. First report on large scleractinian (Cnidaria: Anthozoa) accumulations in cold-temperate shallow water of south Chilean fjords. Zool. Verh. 345:117–128.

France, S. C.
2007. Genetic analysis of bamboo corals (Cnidaria: Octocorallia: Isididae): does lack of colony branching distinguish *Lepidisis* from *Keratoisis*? Bull. Mar. Sci. 81:323–333.

Fujita, T., and S. Ohta.
1988. Photographic observations of the life style of the deep-sea ophiuroid *Asteronyx loveni* (Echinodermata). Deep-sea Res. Oceanogr. Res., A 35:2029–2043. https://doi.org/10.1016/0198-0149(88)90123-9

Goddard, P., R. Wilborn, C. Rooper, K. Williams, R. Towler, M. Sigler, and P. Malecha.
2016. Results of the 2014 underwater camera survey of the

eastern Bering Slope and Outer Shelf. NOAA Tech. Memo. NMFS-AFSC-313, 304 p.

Goldsmith, D. B., C. A. Kellogg, C. L. Morrison, M. A. Gray, R. P. Stone, R. G. Waller, S. D. Brooke, and S. W. Ross.

2018. Comparison of microbiomes of cold-water corals *Primnoa pacifica* and *Primnoa resedaeformis*, with possible link between microbiome composition and host genotype. Sci. Rep. 8:12383. https://doi.org/10.1038/s41598-018-30901-z

Gray, J. E.

1860. II. Revision of the family Pennatulidae, with descriptions of some new species in the British Museum. Ann. Mag. Nat. Hist., Zool. Bot. Geol., Series 3. 5(25–30):20–25.

1867. Additional note on *Corallium johnsoni*. Proc. Zool. Soc. London. 1867:125–127.

1870. Catalogue of lithophytes or stony corals in the collection of the British Museum, 51 p. Order of the Trustees, London.

Gray, M. A., R. P. Stone, M. R. McLaughlin, and C. A. Kellogg.

2011. Microbial consortia of gorgonian corals from the Aleutian Islands. FEMS Microbiol. Ecol. 76:109–120. https://doi.org/10.1111/j.1574-6941.2010.01033.x

Grigg, R. W.

2002. Precious corals in Hawaii: discovery of a new bed and revised management measures for existing beds. Mar. Fish. Rev. 64(1):13–20.

Hartill, E. C., R. G. Waller, and P. J. Auster.

2020. Deep coral habitats in Glacier Bay National Park and Preserve, Alaska. PLoS ONE 15(8):e0236945. https://doi.org/10.1371/journal.pone.0236945

Heifetz, J.

2002. Coral in Alaska: distribution, abundance, and species associations. Hydrobiologia 471:19–28. https://doi.org/10.1023/A:1016528631593

Henry, L.-A., E. L. R. Kenchington, and A. Silvaggio.

2003. Effects of mechanical experimental disturbance on aspects of colony responses, reproduction, and regeneration in the cold-water octocoral *Gersemia rubiformis*. Can. J. Zool. 81:1691–1701. https://doi.org/10.1139/z03-161

Herrera, S., and T. M. Shank.

2016. RAD sequencing enables unprecedented phylogenetic resolution and objective species delimitation in recalcitrant divergent taxa. Mol. Phylogenet. Evol. 100:70–79. https://doi.org/10.1016/j.ympev.2016.03.010

Herrera, S., A. Baco, and J. A. Sánchez.

2010. Molecular systematics of the bubblegum coral genera (Paragorgiidae, Octocorallia) and description of a new deep-sea species. Mol. Phylogenet. Evol. 55:123–135. https://doi.org/10.1016/j.ympev.2009.12.007

Herrera, S., T. M. Shank, and J. A. Sánchez.

2012. Spatial and temporal patterns of genetic variation in the widespread antitropical deep-sea coral *Paragorgia arborea*. Mol. Ecol. 21:6053–6067. https://doi.org/10.1111/mec.12074

Hickson, S. J.

1915. Some Alcyonaria and a *Stylaster* from the west coast of North America. Proc. Zool. Soc. Lond. 85:541–557. https://doi.org/10.1111/j.1469-7998.1915.00541.x

1921. On some Alcyonaria in the Cambridge Museum. Proc. Camb. Philos. Soc., Math. Phys. Sci. 20:366–373.

Hoff, G. R., and B. Stevens.

2005. Faunal assemblage structure of the Patton Seamount (Gulf of Alaska, USA). Alsk. Fish. Res. Bull. 11:27–36.

Horowitz, W. L.

2002. Evaluation of sub-sea physical environmental data for the Beaufort Sea OCS and incorporation into a Geographic Information System (GIS) database. U.S. Dept. Interior, Miner. Manag. Serv., Alsk. Cont. Shelf Reg. OCS Study MMS 2002-017, 66 p. [Available from https://www.boem.gov/sites/default/files/boem-newsroom/Library/Publications/2002/2002-017.pdf.]

Horvath, E. A.

2019. A review of gorgonian coral species (Cnidaria, Octocorallia, Alcyonacea) held in the Santa Barbara Museum of Natural History research collection: focus on species from Scleraxonia, Holaxonia, Calcaxonia – Part III: suborder Holaxonia continued, and suborder Calcaxonia. ZooKeys 860:183–306. https://doi.org/10.3897/zookeys.860.34317

Horvath, E. A., and R. P. Stone.

2018. Another unusual new gorgonian (Anthozoa: Octocorallia: Plexauridae) from the Aleutian Islands of Alaska. Zootaxa 4524:112–120. https://doi.org/10.11646/zootaxa.4524.1.8

Johnson, T.

2003. The Bering Sea and Aleutian Islands: region of wonders. Alsk. Sea Grant Coll. Program, SG-ED-42, 199 p. Univ. Alaska Fairbanks, Fairbanks, AK.

Johnstone, J. W., R. G. Waller, and R. P. Stone.

2021. Shallow-emerged coral may warn of deep-sea coral response to thermal stress. Sci. Rep. 11:22439. https://doi.org/10.1038/s41598-021-01948-2

Keller, N. B.

1977. New species of the genus *Leptopenus* and some peculiarities of deep-sea ahermatypic corals. Tr. Inst. Okeanol. 108:37–43. [In Russian.]

Kinoshita, K.

1907. Vorläufige Mitteilung über einige neue japanische Primnoid-Korallen. Annot. Zool. Jpn. 6:229–237.

1913. Beiträge zur Kenntnis der Morphologie und Stammesgeschichte der Gorgoniden. J. Coll. Sci. Univ. Tokyo 32:1–50. https://doi.org/10.15083/00037767

Kitahara, M. V., S. D. Cairns, and D. J. Miller.

2010. Monophyletic origin of *Caryophyllia* (Scleractinia, Caryophylliidae), with descriptions of six new species. Syst. Biodivers. 8:91–118. https://doi.org/10.1080/14772000903571088

Kölliker, A. von.

1870. Anatomisch-systematische Beschreibung der Alcyonarien. Erste Abtheilung: Die Pennatuliden. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 7:487–602.

1872. Anatomisch-systematische Beschreibung der Alcyonarien, Erste Abtheilung: Die Pennatuliden. Abhandlungen der Senckenbergischen Naturforschenden Gesellschaft 8:85–275, plates 18–24.

1875. Die Pennatulide Umbellula und zwei neue Typen der Alcyonarien. Festschrift zur Feier des fünfundzwanzigjährigen Bestehens der Physicalisch-medicinischen Gesellschaft in Würzburg, 23 p., plates 1–2.

1880. Report on the Pennatulida dredged by H.M.S. *Challenger* during the years 1873–1876. *In* Report on the scientific results of the voyage of H.M.S. *Challenger* during the years 1873–76. Zoology, vol. 1, part 2 (prepared by C. W. Thomson), 41 p., 11 plates. Neill and Co., Edinburgh, Scotland.

Koren, J., and D. C. Danielssen.

1877. Contribution to the natural history of the Pennatulidae living on the Norwegian coast. Fauna Littoralis Nor. 3:82–102, plates 3–4, 9–12.

1883. Nye Alcyonider, Gorgonider og Pennatulider tilhorende Norges Fauna. Bergens Mus. Skr. 2:1–38, plates 1–3.

Krieger, K. J.

2001. Coral (*Primnoa*) impacted by fishing gear in the Gulf of Alaska. *In* Proceedings of the first international symposium on deep-sea corals; Halifax, Nova Scotia, 30 July–2 August 2000 (J. H. M. Willison, J. Hall, S. E. Gass, E. L. R. Kenchington, M. Butler, and P. Doherty, eds.), p. 106–116. Ecol. Action Cent. and Nova Scotia Mus., Halifax, NS, Canada.

Krieger, K. J., and B. L. Wing.

2002. Megafauna associations with deepwater corals (*Primnoa* spp.) in the Gulf of Alaska. Hydrobiologia 471:83–90. https://doi.org/10.1023/A:1016597119297

Kükenthal, W.

1906. Diagnosen neuer japanischer Alcyonaceen. Zool. Anz. 30(8/9):280–289.

1908. Diagnosen neuer Gorgoniden (4 Mittelung.). Zool. Anz. 33(1):9–20.

1915a. System und Stammesgeschichte der Isididae. Zool. Anz. 46:116–126. [Although the publication date of this work is 1916, the article was published in 1915.]

1915b. Pennatularia. Das Tierreich 43:1–132.1919. Wissenschaftliche Ergebnisse der Deutschen Tiefsee-Expedition auf dem Dampfer "Valdivia" 1898–1899. Vol. 13, part 2, Gorgonaria, first half, 646 p.

Lamb, A., and B. P. Hanby.

2005. Marine life of the Pacific Northwest: a photographic encyclopedia of invertebrates, seaweeds and selected fishes, 398 p. Harbour Publ., Madeira Park, BC, Canada.

Langton, R. W., E. W. Langton, R. B. Theroux, and J. R. Uzmann.

1990. Distribution, behavior and abundance of sea pens, *Pennatula aculeata*, in the Gulf of Maine. Mar. Biol. 107:463–469. https://doi.org/10.1007/BF01313430

Lapid, E. D., and N. E. Chadwick.

2006. Long-term effects of competition on coral growth and sweeper tentacle development. Mar. Ecol. Prog. Ser. 313:115–123. https://doi.org/10.3354/meps313115

Lapointe, A., and L. Watling.

2015. Bamboo corals from the abyssal Pacific: *Bathygorgia*. Proc. Biol. Soc. Wash. 128:125–136. https://doi.org/10.2988/0006-324X-128.2.125

Linnaeus, C.

1758. Systema naturae per regna tria naturae, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis (10th revised ed.), vol. 1, 824 p. Holmiae, Laurtenii Salvii.

Lumsden, S. E., T. F. Hourigan, A. W. Bruckner, and G. Dorr (eds.).

2007. The state of deep coral ecosystems of the United States. NOAA Tech. Memo. CRCP-3, 365 p.

Madsen, F. J.

1944. Octocorallia (Stolonifera – Telestacea – Xeniidae – Alcyonacea – Gorgonacea). *In* The Danish Ingolf-Expedition, vol. 5, part 13, 65 p. H. Hagerup, Copenhagen, Denmark.

Malecha, P. W., and R. P. Stone.

2009. Response of the sea whip *Halipteris willemoesi* to simulated trawl disturbance and its vulnerability to subsequent predation. Mar. Ecol. Prog. Ser. 388:197–206. https://doi.org/10.3354/meps08145

Marshall, A. M.

1883. Report on the Pennatulida dredged by H.M.S. "Triton." Trans. R. Soc. Edinb. 32:119–152.

Masuda, M. M., and R. P. Stone.

2015. Bayesian logistic mixed-effects modelling of transect data: relating red tree coral presence to habitat characteristics. ICES J. Mar. Sci. 72:2674–2683. https://doi.org/10.1093/icesjms/fsv163

Matsumoto, A. K.

2005. Recent observations on the distribution of deep-sea coral communities on the Shiribeshi Seamount, Sea of Japan. *In* Cold-water corals and ecosystems (A. Freiwald and J. M. Roberts, eds.), p. 345–356, Springer-Verlag, Berlin, Germany.

2007. Effects of low water temperature on growth and magnesium carbonate concentrations in the cold-water gorgonian *Primnoa pacifica*. Bull. Mar. Sci. 81:423–435.

Matsumoto, A. K., L. P. van Ofwegen, and F. M. Bayer.

2019. A revision of the genus *Calcigorgia* (Cnidaria, Octocorallia, Acanthogorgiidae) with the description of three new species. Zootaxa 4571:1–27. https://doi.org/10.11646/zootaxa.4571.1.1

McFadden, C. S., and F. G. Hochberg.

2003. Biology and taxonomy of encrusting alcyoniid soft corals in the northeastern Pacific Ocean with descriptions of two new genera (Cnidaria, Anthozoa, Octocorallia). Invertebr. Biol. 122:93–113. https://doi.org/10.1111/j.1744-7410.2003.tb00076.x

McFadden, C. S., L. P. van Ofwegen, and A. M. Quattrini.

2022. Revisionary systematics of Octocorallia (Cnidaria: Anthozoa) guided by phylogenomics. Bull. Soc. Syst. Biol. 1(3):8735. https://doi.org/10.18061/bssb.v1i3

Miller, R. J., J. Hocevar, R. P. Stone, and D. V. Fedorov.

2012. Structure-forming corals and sponges and their use as fish habitat in Bering Sea submarine canyons. PLoS ONE 7(3):e33885. https://doi.org/10.1371/journal.pone.0033885

Molodtsova, T. N.

2013. Deep-sea mushroom corals (Octocorallia: Alcyonacea: Alcyoniidae) of the Northern Mid-Atlantic Ridge. Mar. Biol. Res. 9:488–515. https://doi.org/10.1080/17451000.2012.750427

Molodtsova, T. N., and D. M. Opresko.

2017. Black corals (Anthozoa: Antipatharia) of the Clarion-Clipperton fracture zone. Mar. Biodivers. 47:349–365. https://doi.org/10.1007/s12526-017-0659-6

Molodtsova, T. N., and F. A. Pasternak.

2005. Redescription of *Parantipathes euantha* (Pasternak, 1958) (Anthozoa: Antipatharia) from the Kurile-Kamchatka Trench. Invertebr. Zool. 2:169–179. https://doi.org/10.15298/invertzool.02.2.02

Moroff, T.

1902. Studien über Octocorallien. I. Ueber die Pennatulaceen des Münchener Museums. Zoologische Jahrbücher (Syst.) 17:363–403, plates 14–15.

Morrison, C. L., M. J. Springmann, K. M. Shroades, and R. P. Stone.

2015. Development of twelve microsatellite loci in the red tree corals *Primnoa resedaeformis* and *Primnoa pacifica*. Conserv. Genet. Resour. 7:763–765. https://doi.org/10.1007/s12686-015-0455-1

Mortensen, P. B., and L. Buhl-Mortensen.

2005. Morphology and growth of the deep-water gorgonians *Primnoa resedaeformis* and *Paragorgia arborea*. Mar. Biol. 147:775–788. https://doi.org/10.1007/s00227-005-1604-y

Moseley, H. N.

1881. Report on certain hydroid, Alcyonarian, and Madreporarian corals procured during the voyage of H.M.S. *Challenger*, in the years 1873–1876. *In* Report on the scientific results of the voyage of H.M.S. *Challenger* during the years 1873–76, Zoology, vol. 2 (prepared by C. W. Thomson), 248 p. Neill and Co., Edinburgh, Scotland. [While the publication date of this volume is dated 1881, the section referenced here is dated 1880.]

Normark, W. R., and P. R. Carlson.

2003. Giant submarine canyons: is size any clue to their importance in the rock record? *In* Extreme depositional environments: mega end members in geologic time. Geol. Soc. Am. Spec. Pap. 370 (M. A. Chan and A. W. Archer, eds.), p. 175–190. Geol. Soc. Am., Boulder, CO.

Nørrevang, A.

1973. On a peculiar mode of germ-layer formation: the early embryology of *Gersemia rubiformis* (Ehrenberg 1834) (Octocorallia). Acta Zool. 54:65–71. https://doi.org/10.1111/j.1463-6395.1973.tb00443.x

NRC (National Research Council).

1990. Assessment of the U.S. outer continental shelf environment studies program: 1. physical oceanography, 144 p. Natl. Acad. Press, Washington, DC. https://doi.org/10.17226/1609

Nutting, C. C.

1908. Descriptions of the Alcyonaria collected by the U.S. Bureau of Fisheries steamer *Albatross* in the vicinity of the Hawaiian Islands in 1902. Proc. U. S. Natl. Mus. 34:543–601.

1909. Alcyonaria of the California coast. Proc. U. S. Natl. Mus. 35(1658):681–727. https://doi.org/10.5479/si.00963801.35-1658.681

1912. Descriptions of the Alcyonaria collected by the U. S. Fisheries steamer "*Albatross*," mainly in Japanese waters, during 1906. Proc. U.S. Natl. Mus. 43(1923):1–104. https://doi.org/10.5479/si.00963801.43-1923.1

Opresko, D. M.

2003. Revision of the Antipatharia (Cnidaria: Anthozoa). Part III. Cladopathidae. Zool. Meded. 77:495–536.

2005. New genera and species of antipatharian corals (Cnidaria: Anthozoa) from the North Pacific. Zool. Meded. 79-2:129–165.

Opresko, D. M., and T. N. Molodtsova.

2021. New species of deep-sea antipatharians from the North Pacific (Cnidaria: Anthozoa: Antipatharia), Part 2. Zootaxa 4999:401–422. https://doi.org/10.11646/zootaxa.4999.5.1

Opresko, D., D. Tracey, and E. Mackay.

2014. Antipatharia (black corals) for the New Zealand region. A field guide of commonly sampled New Zealand black corals including illustrations highlighting technical terms and black coral morphology. N. Z. Aquat. Environ. Biodivers. Rep. 131, 20 p. [Available from https://www.mpi.govt.nz/dmsdocument/4377-aebr-131-antipatharia-black-corals-for-the-new-zealand-region.]

Pante, E., and S. C. France.

2010. *Pseudochrysogorgia bellona* n. gen., n. sp.: a new genus and species of chrysogorgiid octocoral (Coelenterata, Anthozoa) from the Coral Sea. Zoosystema 32:595–612. https://doi.org/10.5252/z2010n4a4

Pante, E., S. C. France, A. Couloux, C. Cruaud, C. S. McFadden, S. Samadi, and L. Watling.

2012. Deep-sea origin and in-situ diversification of chrysogorgiid octocorals. PLoS ONE 7(6):e38357. https://doi.org/10.1371/journal.pone.0038357

Pasternak, F. A.

1958. Die Tiefsee Antipatharien des Kurilen-Kamchatka Grabens. Trud. Inst. Oceanol. 27:180–191.

1977. Antipatharia. *In* Galathea report. Scientific results of the Danish deep-sea expedition around the world, 1950–52, vol. 14 (T. Wolff, ed.), p. 157–164. Scand. Sci. Press, Copenhagen, Denmark.

Penn, K., D. Wu, J. A. Eisen, and N. Ward.

2006. Characterization of bacterial communities associated with deep-sea corals on Gulf of Alaska seamounts. Appl. Environ. Microbiol. 72:1680–1683. https://doi.org/10.1128/AEM.72.2.1680-1683.2006

Pérez, C. D., R. T. S. Cordeiro, G. C. Williams, and P. B. Gomes.

2021. Revised nomenclature of the sea pen genus *Balticina* Gray, 1870 (= *Halipteris* Kölliker, 1870) (Anthozoa: Octocorallia). Zootaxa 4966:237–244. https://doi.org/10.11646/zootaxa.4966.2.10

Pires, D. O., C. B. Castro, and J. C. Silva.

2009. Reproductive biology of the deep-sea pennatulacean *Anthoptilum murrayi* (Cnidaria, Octocorallia). Mar. Ecol. Prog. Ser. 397:103–112. https://doi.org/10.3354/meps08322

Reece, R. S., S. P. S. Gulick, B. K. Horton, G. L. Christeson, and L. L. Worthington.

2011. Tectonic and climatic influence on the evolution of the Surveyor Fan and Channel system, Gulf of Alaska. Geosphere 7:830–844. https://doi.org/10.1130/GES00654.1

Reimer, J. D., and F. Sinniger.

2010. Unexpected diversity in Canadian Pacific zoanthids (Cnidaria: Anthozoa: Hexacorallia): a molecular examination and description of a new species from the waters of British Columbia. Mar. Biodivers. 40:249–260. https://doi.org/10.1007/s12526-010-0045-0

Roark, E. B., T. P. Guilderson, S. Flood-Page, R. B. Dunbar, B. L. Ingram, S. J. Fallon, and M. McCulloch.

2005. Radiocarbon-based ages and growth rates of bamboo corals from the Gulf of Alaska. Geophys. Res. Lett. 32:L04606. https://doi.org/10.1029/2004GL021919

Roark, E. B., T. P. Guilderson, R. B. Dunbar, and B. L. Ingram.

2006. Radiocarbon-based ages and growth rates of Hawaiian deep-sea corals. Mar. Ecol. Prog. Ser. 327:1–14. https://doi.org/10.3354/meps327001

Roberts, J. M., A. Wheeler, A. Freiwald, and S. Cairns.

2009. Cold-water corals: the biology and geology of deep-sea coral habitats, 334 p. Cambridge Univ. Press, Cambridge, UK.

Rossin, A. M., R. G. Waller, and R. P. Stone.

2019. The effects of *in-vitro* pH decrease on the gametogenesis of the red tree coral, *Primnoa pacifica*. PLoS ONE 14(4):e0203976. https://doi.org/10.1371/journal.pone.0203976

Ryland, J. S., and J. E. Lancaster.
2003. Revision of methods for separating species of Protopalythoa (Hexacorallia: Zoanthidea) in the tropical West Pacific. Invertebr. Syst. 17:407–428. https://doi.org/10.1071/IS02008

Saenger, C., R. I. Gabitov, J. Farmer, J. M. Watkins, and R. Stone.
2017. Linear correlations in bamboo coral $\delta^{13}C$ and $\delta^{18}O$ sampled by SIMS and micromill: evaluating paleoceanographic potential and biomineralization mechanisms using $\delta^{11}B$ and Δ_{47} composition. Chem. Geol. 454:1–14. https://doi.org/10.1016/j.chemgeo.2017.02.014

Sanamyan, K. E., and N. P. Sanamyan (eds.).
2020. Flora and fauna of Matua Island (middle Kuril Island): the field guide. Volume 1: Sea, 495 p. OOO Intron, Cherepovets, Russia. [Available from http://sanamyan.com/matua/eng.php, in Russian.]

Sánchez, J. A.
2005. Systematics of the bubblegum corals (Cnidaria: Octocorallia: Paragorgiidae) with description of new species from New Zealand and the Eastern Pacific. Zootaxa 1014:1–72. https://doi.org/10.11646/zootaxa.1014.1.1

Sánchez, J. A., and S. D. Cairns.
2004. An unusual new gorgonian coral (Anthozoa: Octocorallia) from the Aleutian Islands, Alaska. Zool. Meded. 78:265–274.

Saucier, E. H., S. C. France, and L. Watling.
2021. Toward a revision of the bamboo corals: part 3, deconstructing the family Isididae. Zootaxa 5047:247–272. https://doi.org/10.11646/zootaxa.5047.3.2

Sebens, K. P., and J. S. Miles.
1988. Sweeper tentacles in a gorgonian octocoral: morphological modifications for interference competition. Biol. Bull. 175:378–387. https://doi.org/10.2307/1541729

Seravin, L. N., and A. V. Gudkov.
1990. Spontaneous and periodic changes in the form and size of the alcyonarian colony of *Gersemia fruticosa* (Alcyonacea, Nephthyidae). Translated by the Laboratory of Invertebrate Zoology, Biological Research Institute, Leningrad University, Leningrad, Staryi Petergof. Biol. Morya 3:9–12.

Sherwood, O. A., and E. N. Edinger.
2009. Ages and growth rates of some deep-sea gorgonian and antipatharian corals of Newfoundland and Labrador. Can. J. Fish. Aquat. Sci. 66:142–152. https://doi.org/10.1139/F08-195

Sinniger, F., and V. Häussermann.
2009. Zoanthids (Cnidaria: Hexacorallia: Zoantharia) from shallow waters of the southern Chilean fjord region, with descriptions of a new genus and two new species. Org. Divers. Evol. 9:23–36. https://doi.org/10.1016/j.ode.2008.10.003

Sinniger, F., J. D. Reimer, and J. Pawlowski.
2010. The Parazoanthidae (Hexacorallia: Zoantharia) DNA taxonomy: description of two new genera. Mar. Biodivers. 40:57–70. https://doi.org/10.1007/s12526-009-0034-3

Sinniger, F., O. V. Ocaña, and A. R. Baco.
2013. Diversity of zoanthids (Anthozoa: Hexacorallia) on Hawaiian seamounts: description of the Hawaiian gold coral and additional zoanthids. PLoS ONE 8(1):e52607. https://doi.org/10.1371/journal.pone.0052607

Slephkova, N. A., and L. N. Seravin.
1983. Spontaneous and induced stretching of polyps in the coral *Gersemia fruticosa* (Alcyonacea, Nephthyidae). Zool. Zh. 62:675–680. [In Russian.]

Squires, D. F.
1962. The fauna of the Ross Sea. Part 2. Scleractinian corals. N. Z. Oceanogr. Inst. Mem. 19, 28 p.

Stearns, R. E. C.
1883. Descriptions of a new genus and species of alcyonoid polyp, from Japanese waters, with remarks on the structure and habits of related forms, etc. Proc. U.S. Nat. Mus. 6:96–101.

Stone, R. P.
2006. Coral habitat in the Aleutian Islands of Alaska: depth distribution, fine-scale species associations, and fisheries interactions. Coral Reefs 25:229–238. https://doi.org/10.1007/s00338-006-0091-z
2014. The ecology of deep-sea coral and sponge habitats of the central Aleutian Islands of Alaska. NOAA Prof. Pap. NMFS 16, 52 p.

Stone, R. P., and S. D. Cairns.
2017. Deep-sea coral taxa in the Alaska region: depth and geographic distribution, 9 p. Natl. Mar. Fish. Serv., Silver Spring, MD. [Available from https://deepseacoraldata.noaa.gov/library/2017-state-of-deep-sea-corals-report.]

Stone, R. P., and J. Mondragon.
2018. Deep-sea emergence of red tree corals (*Primnoa pacifica*) in Southeast Alaska glacial fjords. NOAA Prof. Pap. NMFS 20, 33 p.

Stone, R. P., and C. N. Rooper.
2017. State of the deep-sea coral and sponge ecosystems of the Alaska Region. *In* The state of deep-sea coral and sponge ecosystems of the United States (T. F. Hourigan, P. J. Etnoyer, and S. D. Cairns, eds.), p. 57–92. NOAA Tech. Memo. NMFS-OHC-4.

Stone, R. P., and S. K. Shotwell.
2007. State of deep coral ecosystems in the Alaska Region: Gulf of Alaska, Bering Sea and the Aleutian Islands. *In* The state of deep coral ecosystems of the United States (S. E. Lumsden, T. F. Hourigan, A. W. Bruckner, and G. Dorr, eds.), p. 65–108. NOAA Tech. Memo. CRCP-3.

Stone, R. P., and B. L. Wing.
2001. Growth and recruitment of an Alaskan shallow-water gorgonian. *In* Proceedings of the first international symposium on deep-sea corals; Halifax, Nova Scotia, 30 July–2 August 2000 (J. H. M. Willison, J. Hall, S. E. Gass, E. L. R. Kenchington, M. Butler, and P. Doherty, eds.), p. 88–94. Ecol. Action Cent. and Nova Scotia Mus., Halifax, NS, Canada.

Stone, R. P., M. M. Masuda, and P. W. Malecha.
2005. Effects of bottom trawling on soft-sediment epibenthic communities in the Gulf of Alaska. Am. Fish. Soc. Symp. 41:439–453. https://doi.org/10.47886/9781888569605.ch70

Stone, R. P., H. Lehnert, and H. Reiswig.
2011. A guide to the deep-water sponges of the Aleutian Island Archipelago. NOAA Prof. Pap. NMFS 12, 187 p.

Stone, R. P., K. W. Conway, D. J. Csepp, and J. V. Barrie.
2013. The boundary reefs: glass sponge (Porifera: Hexactinellidae) reefs on the international border between Canada and the United States. NOAA Tech. Memo. NMFS-AFSC-264, 31 p.

Stone, R. P., D. Stevenson, and S. Brooke.
2015a. Assessment of a pilot study to collect coral bycatch data from the Alaska commercial fishing fleet. NOAA Tech. Memo. NMFS-AFSC-296, 45 p.

Stone, R. P., M. M. Masuda, and J. F. Karinen.
2015b. Assessing the ecological importance of red tree coral thickets in the eastern Gulf of Alaska. ICES. J. Mar. Sci. 72:900–915. https://doi.org/10.1093/icesjms/fsu190

Stone, R. P., P. W. Malecha, and M. M. Masuda.
2017. A five-year, *in situ* growth study on shallow-water populations of the gorgonian octocoral *Calcigorgia spiculifera* in the Gulf of Alaska. PLoS ONE 12(1):e0169470. https://doi.org/10.1371/journal.pone.0169470

Studer, T.
1878. Ubersicht der Anthozoa Alcyonaria welche wahrend der Reise S.M.S. Gazelle um die Erde gesammelt wurden. Mon. K. Preuss. Akad. Wiss. Berlin. 1878:632–688.
1894. Note préliminaire sur les Alcyonaires. Reports on the dredging operations off the West Coast of Central America to the Galapagos, to the West Coast of Mexico, and in the Gulf of California, in charge of Alexander Agassiz, carried on by the U.S. Fish Commission steamer "Albatross," during 1891. Bull. Mus. Comp. Zool. 25:53–69.

Taylor, M. L., S. D. Cairns, D. J. Agnew, and A. D. Rogers.
2013. A revision of the genus *Thouarella* Gray, 1870 (Octocorallia: Primnoidae), including an illustrated dichotomous key, a new species description, and comments on *Plumarella* Gray, 1870 and *Dasystenella*, Versluys, 1906. Zootaxa 602:1–105. https://doi.org/10.11646/zootaxa.3602.1.1

Tendal, O. S.
1992. The North Atlantic distribution of the octocoral *Paragorgia arborea* (L., 1758) (Cnidaria, Anthozoa). Sarsia 77:213–217. https://doi.org/10.1080/00364827.1992.10413506

Thoma, J. N.
2013. Molecular and morphological diversity of sea fans with emphasis on deep-sea octocorals of the order Alcyonacea Lamouroux, 1812. Ph.D. diss., 170 p. Univ. Louisiana, Lafayette, LA. [Available from https://ull.ent.sirsi.net/client/en_US/ull/search/detailnonmodal/ent:$002f$002fSD_ULL$002f0$002fSD_ULL:2196153/one.]

Thomson, J. A.
1927. Alcyonaires provenant des campagnes scientifiques du Prince Albert Ier de Monaco. Résultats des Campagnes Scientifiques Accomplies sur son yacht par Albert Ier. 73:1–77, 6 plates.

Tracey, D., H. Neil, D. Gordon, and S. O'Shea.
2003. Chronicles of the deep: ageing deep-sea corals in New Zealand waters. Water Atmos. 11(2):22–24.

Turner, D. L., R. B. Forbes, and C. W. Naeser.
1973. Radiometric ages of Kodiak seamount and Giacomini guyot, Gulf of Alaska: implications for circum-Pacific tectonics. Science 182:579–581. https://doi.org/10.1126/science.182.4112.579

Tuskes, P. M., and R. Clark.
2018. A new species of *Otukaia* (Calliostomatidae) from Alaska. Festivus 50:236–238.

Utinomi, H.
1976. A review of the Japanese species of *Alcyonium*, with descriptions of two new species and an almost forgotten rare species (Octocorallia, Alcyonacea). Publ. Seto Mar. Biol. Lab. 23(3/5):191–204.

Vallier, T. L., D. W. Scholl, M. A. Fisher, T. R. Bruns, F. H. Wilson, R. von Huene, and A. J. Stevenson.
1994. Geologic framework of the Aleutian arc, Alaska. *In* The geology of Alaska (G. Plafker and H. C. Berg, eds.), p. 367–388. Geol. Soc. Am., Boulder, CO.

Vaughan, T. W.
1900. A new fossil species of *Caryophyllia* from California, and a new genus and species of turbinolid coral from Japan. Proc. U.S. Natl. Mus. 22:199–203. https://doi.org/10.5479/si.00963801.22-1194.199
1906. Reports on the scientific results of the expedition to the Eastern Tropical Pacific, in charge of Alexander Agassiz, by the U. S. Fish Commission Steamer "Albatross" from October, 1904, to March, 1905, Lieut. Commander L. M. Garrett, U. S. N. commanding. Part 6: Madreporaria. Bull. Mus. Comp. Zool. Harv. Univ. 50:59–72.
1941. New corals: one Recent, Alaska; three Eocene, Alabama and Louisiana. J. Paleontol. 15:280–284.

Verrill, A. E.
1864. List of the polyps and corals sent by the Museum of Comparative Zoology to other institutions in exchange, with annotations. Bull. Mus. Comp. Zool. Harv. Univ. 1(3):29–60.
1866. Synopsis of the polyps and corals of the North Pacific exploring expedition, under Commodore C. Ringgold and Captain John Rodgers, U. S. N., from 1853 to 1856. Collected by Dr. Wm. Stimpson, naturalist to the expedition. With descriptions of some additional species from the west coast of North America. Part 2: Alcyonaria. With two plates. Proc. Essex Inst. 4:181–196. [While the publication date of this work is 1866, this chapter was written in 1865.]
1871. Notes on the Radiata in the Museum of Yale College, with description on new genera and species. No. 6. Review of the corals and polyps of the West Coast of America. Trans. Conn. Acad. Arts Sci. 1(2):377–558. [The description was presented in 1868 but the publication that it appears in was published in 1871.]
1879. Notice of recent additions to the marine fauna of the eastern coast of North America, No. 3. Am. J. Sci. Arts, Ser. 3, 17:239–243.
1922. Report of the Arctic expedition 1913–18. Volume 8. Mollusks, echinoderms, coelenterates, etc. Part G. Alcyonaria and Actinaria, 165 p. F. A. Acland, Ottawa, ON, Canada.

Verseveldt, J., and L. P. van Ofwegen.
1992. New and redescribed species of *Alcyonium* Linnaeus, 1758 (Anthozoa: Alcyonacea). Zool. Meded. 66(7):155–181.

Versluys, J.
1902. Die Gorgoniden der Siboga-Expedition. I. Die Chrysogorgiiden, Siboga Exped. Monogr. 13, 120 p.

Von Huene, R.
1989. Continental margins around the Gulf of Alaska. *In* Eastern Pacific Ocean and Hawaii (E. L. Winterer, D. M. Hussong, and R. W. Decker, eds.), p. 383–401. Geol. Soc. Am., Boulder, CO.

Waller, R. G., R. P. Stone, J. Johnstone, and J. Mondragon.
2014. Sexual reproduction and seasonality of the Alaskan red tree coral, *Primnoa pacifica*. PLoS ONE 9(4):e90893. https://doi.org/10.1371/journal.pone.0090893

Waller, R. G., R. P. Stone, L. N. Rice, J. Johnstone, A. M. Rossin, E. Hartill, K. Feehan, and C. L. Morrison.

2019. Phenotypic plasticity or a reproductive dead end? *Primnoa pacifica* (Cnidaria: Alcyonacea) in the southeastern Alaska region. Front. Mar. Sci. 6:709. https://doi.org/10.3389/fmars.2019.00709

Watling, L., S. C. France, E. Pante, and A. Simpson.

2011. Biology of deep-water octocorals. Adv. Mar. Biol. 60:41–122. https://doi.org/10.1016/B978-0-12-385529-9.00002-0

Williams, B., M. Risk, R. Stone, D. Sinclair, and B. Ghaleb.

2007. Oceanographic changes in the North Pacific Ocean over the past century recorded in deep-water gorgonian corals. Mar. Ecol. Prog. Ser. 335:85–94. https://doi.org/10.3354/meps335085

Williams, G. C.

1986. Morphology, systematics, and variability of the southern African soft coral *Alcyonium variabile* (J. Stuart Thomson, 1921) (Octocorallia, Alcyoniidae). Ann. South Afr. Mus. 96:241–270.

1995. Living genera of sea pens (Coelenterata: Octocorallia: Pennatulacea): illustrated key and synopses. Zool. J. Linn. Soc. 113:93–140. https://doi.org/10.1006/zjls.1995.0004

2005. New taxa of octocorals (Anthozoa: Octocorallia) from the northeastern Pacific Ocean. Proc. Calif. Acad. Sci. 56:53–65.

2013. New taxa and revisionary systematics of alcyonacean octocorals from the Pacific coast of North America (Cnidaria, Anthozoa). ZooKeys 283:15–42. https://doi.org/10.3897/zookeys.283.4803

Williams, G. C., and P. Alderslade.

2011. Three new species of pennatulacean octocorals with the ability to attach to rocky substrata (Cnidaria: Anthozoa: Pennatulacea). Zootaxa 3001:33–48. https://doi.org/10.11646/zootaxa.3001.1.2

Williams, G. C., and L. Lundsten.

2009. The nephtheid soft coral genus *Gersemia* Marenzeller, 1878, with the description of a new species from the northeast Pacific and a review of two additional species (Octocorallia: Alcyonacea). Zool. Meded. 83:1067–1081.

Williams, G. C., B. W. Hoeksema, and L. P. van Ofwegen.

2012. A fifth morphological polyp in pennatulacean octocorals, with a review of polyp polymorphism in the genera *Pennatula* and *Pteroeides* (Anthozoa: Pennatulidae). Zool. Stud. 51:1006–1017.

Wilson, M. T., A. H. Andrew, A. L. Brown, and E. E. Cordes.

2002. Axial rod growth and age estimation of the sea pen, *Halipteris willemoesi* Kölliker. Hydrobiologia 471:133–142.

Wing, B. L., and D. B. Barnard.

2004. A field guide to Alaskan corals. NOAA Tech. Memo. NMFS-AFSC-146, 67 p.

Wood, R. L.

1957. Identification and microanatomical study of a new species of *Epizoanthus* (Zoanthidea). Diss. Abstr. 18(2):707–708.

WoRMS Editorial Board.

2022. World Register of Marine Species. https://doi.org/10.14284/170

Wright, E. P.

1885. The Alcyonaria. *In* Report of the scientific results of the voyage of H.M.S. *Challenger*. Narrative – volume 1, part 2 (C. W. Thomson and J. Murray, eds.), p. 689–693. Neill and Co., Edinburgh, Scotland.

Wright, E. P., and T. Studer.

1889. Report on the Alcyonaria collected by H.M.S. *Challenger* during the years 1873–1876. *In* Report of the scientific results of the voyage of H.M.S. *Challenger* during the years 1873–76. Zoology, vol. 31, 314 p. Neill and Co., Edinburgh, Scotland.

Yamada, M.

1950. Descriptions of two *Alcyonium* from northern Japan. Annot. Zool. Jpn. 23:114–116.

Appendix I. Glossary

Order Antipatharia (Adapted from Opresko et al., 2014)

Abpolypar: on the side of the skeletal axis opposite to the side bearing the polyps

Actinopharynx: cylindrical tube of tissue leading down from the mouth and supported internally by radial mesenteries (also referred to as septa in earlier literature)

Alternating (arrangement of pinnules): pinnules in lateral rows offset from each other

Anisomorphic: unequal development of the spines in the immediate area of the polyps; the hypostomal spines are reduced in size; the circumpolypar spines are enlarged; and the interpolypar spines are of an intermediate size

Basal: in a direction towards the attachment point of a pinnule, branchlet, branch, or stem

Basal diameter: diameter of the axis just above the attachment plate or holdfast

Branchlets: smallest ramifications of a corallum, usually of varying size and orientation

Circumpolypar: area around the outer edge of the polyps, beneath the tentacles

Complete mesenteries (septa): radially arranged endodermal partitions joining the actinopharynx to the interior body wall of the polyp

Corallum: the skeletal structure of the colony

Distal: direction towards the tip of a pinnule, branchlet, branch, or stem

Distal angle: the angle formed by the upper side of the spines or branches, and the axis

Distal lateral tentacles: the pair of tentacles at the distal end of a polyp

Hypostomal: the area on the skeletal axis directly below the mouth of the polyp

Interpolypar: the area between the distal lateral tentacles of one polyp and the proximal lateral tentacles of the adjoining one

Lateral tentacles: the pairs of tentacles at the distal and proximal extremities of a polyp

Mesentery (septa): six, 10, or 12 partitions of tissue which extend across from the inside wall of the polyp to the actinopharynx in a radial pattern (when viewed in cross sectional view)

Monopodial: having a stem extending to the top of the corallum

Mutual distance (of spines): the distance between the midpoints of the bases of adjacent spines or branches

Oral cone: an elevated area of tissue around the mouth of a polyp

Peristome: the area on the surface of a polyp between the mouth and tentacles

Pinnulate: having symmetrically arranged, simple or branched ramifications of subequal size on the stem and branches of the corallum

Pinnules: symmetrically arranged, simple or branched ramifications of nearly equal length located on the stem and branches of the corallum

Polypar spines: spines on the side of the axis that bear the polyps; not restricted to the immediate area of each individual polyp

Primary mesenteries: six internal partitions of tissue each extending across from the actinopharynx radially to the interior wall of the polyp and down to the aboral margin of the actinopharynx, thereby defining the boundaries of the six tentacles, and appearing in cross section as spokes of a wheel

Primary pinnules: small branchlets of a colony that are usually of equal size and arranged in a symmetric pattern around the axis (they may be simple or bear subpinnules)

Proximal lateral tentacles: the pair of tentacles on the side of the polyp closest to the base of the branch/pinnule bearing the polyp

Sagittal axis: a plane through the center of the actinopharynx, perpendicular to the direction of the stem or branch bearing the polyp

Sagittal tentacles: the median pair of tentacles whose members are placed on either side of the mouth and in a plane, which is perpendicular to the direction of the branch bearing the polyp

Sclerenchyme: skeletal axis composed of concentric layers of protein and chitin

Secondary mesenteries: complete mesenteries which are not attached all the way to the aboral edge of the actinopharynx

Secondary pinnules: very small ramifications that arise from the primary pinnules; often arranged uniserially or bilaterally and sometimes giving rise to tertiary pinnules

Semispiral (arrangement of pinnules): groups of pinnules (one from each of the longitudinal rows) on either side of a branch or stem which are offset slightly to those from which they form a curved ascending or descending pattern around the circumference of the axis

Septa: see **mesentery**

Simple (pinnule): without further sub-ramifications

Siphonoglyph: a ciliary tract extending in an oral-aboral direction on the sagittal border of the actinopharynx

Stalk: the lowermost unpinnulated part of the stem in monopodial pinnulated colonies, especially those of *Bathypathes* species

Stem: the primary axis of a colony that arises from the holdfast and from which branches or pinnules may or may not arise

Subopposite (arrangement of pinnules): pinnules in lateral rows grouped together in pairs whose members are almost directly opposite one another

Subpinnules: general term for one or more orders of small ramifications which can arise from the primary pinnules, and consisting of secondary, tertiary, and quaternary pinnules

Tertiary pinnules: very small ramifications that arise from the secondary pinnules; usually arranged uniserially, and sometimes giving rise to quaternary pinnules

Transverse axis: a plane through the center of the actinopharynx in the direction of the branch bearing the polyp

Verticillate (arrangement of pinnules): pinnules grouped in whorls around the circumference of the axis

Order Scleractinia (Adapted from Cairns and Kitahara, 2012)

Axial septal edge: the inner edge of a septum, adjacent to the fossa and/or columella (see Fig. 3-1)

Basal plate: the thin encrusting calcareous plate secreted by the planula when first attaching to a substrate

Calice: the skeletal analog of the polyp, cupping the polyp from below, and consisting of the septa, and, if present, the columella and pali (see Fig. 3-1)

Ceratoid: the triangular shape of a solitary corallum created if the sides of the corallum diverge at an angle of 10°–40°

Columella: an axial structure of diverse shape and composition that projects from the center of a calice; if composed of twisted lamellae, it is termed fascicular (see Fig. 3-1)

Corallum (coralla): the aragonitic calcium carbonate skeleton of a scleractinian coral

Costa (costae): continuation of a septum on the outside of the corallite wall, often as a ridge or low linear mound (see Fig. 3-1)

Cycle: see **septum**

Epitheca: thin, external smooth or wrinkled, non-trabecular sheath (wall) surrounding individual corallites

Exsert septum: a septum whose distal edge projects above the thecal rim (Fig. 3-1)

Fascicular: see **columella**

Fossa: the central region of a corallite, in which the polyp sits (see Fig. 3-2)

Half-system: one twelfth of the septa of a calice, consisting of the septa between an S1 and an adjacent S2 (see Fig. 3-2)

Palus (pali): small flattened lobe on the axial edge of various septal cycles, always one per septum

Pedicel: the stem-like region of a solitary coral just above the base and below the calicular surface (see Fig. 3-1)

Polycyclic base: the lower several millimeters of a solitary corallum that is composed of concentric rings of partitioned chambers

Polyp: the fleshy non-skeletal part of the coral, consisting of tentacles, mouth, and mesenteries

Porcelaneous: smooth, polished

Pourtalès plan: a form of septal arrangement in which the axial edges of pairs of higher cycle septa bend in front of and unite before their adjacent lower cycle septum (see Fig. 3-2)

Protosepta: the first septa deposited by a planula after settlement, usually 6 or 12 in number

Septal formula: a shorthand notation to indicate the relative widths of the respective septal cycles, thus S1–2>S3>S4 would mean that the septa of the first two cycles are equal in width and wider than those of the third cycle septa, which in turn are wider than those of the fourth cycle septa

Septum (septa): radially arranged longitudinal partitions of a corallite, usually arranged in hexameral symmetry; septa are added in cycles, with the first cycle composed of 6 septa, the second of 6, the third of 12, the fourth of 24, etc.; the first cycle septa are designated as S1, the second as S2, etc. (see Fig. 3-1)

Stereome: a general term for thick calcareous deposits on various parts of the corallum

Synapticulotheca: a porous wall of a solitary corallum, characteristic of the family Dendrophylliidae

System: one sixth of the septa of a corallum, consisting of the septa between two adjacent S1 (see Fig. 3-2)

Theca: the wall of a solitary corallum (see Fig. 3-1)

Trabecular spine: linearly arranged spines that project from the upper septal edges

Trochoid: the triangular shape of a solitary corallum created if the sides of the corallum diverge at an angle of 40°–60°

Order Zoantharia (Adapted from Ryland and Lancaster, 2003)

Capitulum: top part of the contracted polyp formed by the contracted tentacles

Cnidae: explosive cells containing one giant secretory organelle that can deliver a sting to other organisms; zoantharians possess five main types of cnidae with many variations: spirocysts, spirulae, penicilli, basitrichs, and homotrichs (equivalent to **nematocysts**)

Cnidome: the specific complement of cnidae for a given species

Gastrodermal canals: canals that connect the individual polyps through the coenenchyme (also referred to as mesogloeal canals)

Macrocnemes: fully developed mesenteries

Mesogloea: the connective tissue layer between the epidermis and gastrodermis

Scapulus: the oral disc of each polyp in the colony

Scapus: the column of the polyp from the base to the capitulum

Siphonoglyph: the strongly ciliated grooves extending down one side of the pharynx

Subclass Octocorallia (Adapted from Bayer et al., 1983)

Abaxial: away from the axis

Acanthose: thorny

Adaxial: towards the axis

Anthocodia: the distal part of a polyp bearing the mouth and the tentacles

Anthostele: the proximal, rigid part of some polyps, often stiffened by sclerites, and into which the anthocodia may be withdrawn (equivalent to **calyx**)

Arborescent: tree-like colonies with a definite stalk

Autozooid: a polyp with eight well-developed tentacles and mesenteries; the larger polyp in dimorphic species that is typically responsible for food capture and reproduction

Axial sheath: the coenenchyme immediately surrounding the axis

Axis: the inner supporting structure that in octocorals may be composed of aragonite, high-magnesium calcite, low-magnesium calcite, horny material, or a combination of these compounds

Bottlebrush: pinnately branched colonies in which numerous, crowded, short branchlets arise all around the main stalk

Buccal: pertaining to the mouth cavity

Bushy: colonies with abundant branches arising immediately above the holdfast and not forming an obvious main stem

Calyx (calyces): cylindrical or wart-like projecting anthostele

Capitate: unbranched colonies with a broad distal section on a distinctly narrower stalk

Capitulum: disc-shaped or hemispherical, polypiferous section of an alcyonacean colony (family Alcyoniidae)

Central chord: the central part of the axis in order Malacalcyonacea, made up of horny material and to some degree calcareous material

Clavate: club-shaped or a terminally enlarged branch

Clubs: monaxial sclerites enlarged at the head end and tapered at the handle end

Coenenchyme: the colonial tissue between polyps consisting of mesogloea usually containing sclerites and penetrated by a network of gastrodermic canals

Collaret: (see **crown**)

Colony: a group of interconnected, genetically identical, elementary functional units (i.e., the polyps)

Contractile polyp: a polyp that can diminish in size without introversion; the tentacles alone may be folded inward over the mouth, but there is no neck zone or introvert that provides for withdrawal of the entire anthocodia into the anthostele or coenenchyme

Cross: a stellate sclerite with four rays in one plane

Crown: the ring of transversely placed, usually bow-shaped sclerites encircling the anthocodia below the tentacles (equivalent to **collaret**)

Crown and points: the combined arrangement of the sclerites of the crown and the points

Dichotomous branching: a branching pattern of repeated bifurcation

Dimorphism: the presence of two types of polyps: autozooids and siphonozooids

Distad: toward or near the distal part or end

Double star: a rod sclerite with two whorls of irregularly shaped, more or less spiny projections

***En chevron*:** *V*-shaped

Flagelliform: stout, unbranched, whip-like colonies

Fusiform: tapered at each end; spindle-shaped

Gastric cavity: the interior space of a polyp

Holdfast: the part of the colony that attaches to the substrate

Internode: the rigid calcareous segment of the Keratoisididae axis that is white or creamy white in color

Introvert: (equivalent to **neck zone**)

Irregular branching: branching that originates irregularly (neither pinnate nor dichotomous) in planar or nearly planar colonies

Loculus (loculi): a calcified or fiber-filled space in the axes of malacalcyonaceans (particularly those in the former family Plexauridae) that in cross section may appear crescentic or lenticular

Medulla: the inner supporting structure of some corals (equivalent to **central chord** of malacalcyonaceans and **axis** in scleralcyonaceans)

Mesenteries: the thin, radial, non-calcareous partitions that join the pharynx to the body wall and divide the gastrovascular cavity of the polyp

Mesogloea: a jelly-like substance separating the two epithelial layers and containing many cells

Mesozooid: a polyp intermediate between an autozooid and a syphonozooid

Monopodial branching: branching that occurs when the main axis of the colony maintains a single line of growth but gives rise to a few or many lateral branches

Morph: a subset of individuals of a particular variant of a species that exhibits a distinct morphological feature(s)

Neck zone: the soft, thin-walled basal part of an anthocodia, with few sclerites and providing for the introversion of the anthocodia into the anthostele (equivalent to **introvert**)

Needles: long, thin, nearly smooth monaxial sclerites

Node: the flexible horny joint of the calcified axis in Keratoisididae that is typically black or brown in color

Obconic: in the form of an inverted cone, attached at the pointed end

Operculum: eight triangular scales covering the withdrawn tentacles in species of the family Primnoidae

Oral disc: the area of the polyp immediately surrounding the mouth and formed by the inner parts of the tentacles

Pharynx: the tubular passageway between the mouth and the gastric cavity

Pinnate tentacles: tentacles bearing pinnules that are characteristic of all Octocorallia

Pinnules: the lateral processes of the tentacle

Plates: flat sclerites that are much thicker than scales, circular to oval, but often irregular in shape

Points: the eight rows of *en chevroned* (i.e., *V*-shaped) sclerites in the distal part of the anthocodia and superposing the crown (if present)

Polyp: an individual of an octocoral colony (equivalent to **autozooid**, **siphonozooid**, and **mesozooid**)

Radiates: sclerites with processes radiating in one plane (i.e., stellate forms) or in various planes in a more or less symmetrical order

Retractile polyp: a polyp in which the anthocodia can invert completely into the anthostele or coenenchyme

Rhizoids: the rootlike processes extending from the base of some colonies

Rods: straight or curved monaxial sclerites that are blunt at both ends

Scales: thin, flat, or nearly flat sclerites

Sclerite: multi-formed calcareous structures found in the mesogloea and elsewhere in the colony

Siphonoglyph: the strongly ciliated grooves extending down one side of the pharynx

Siphonozooid: a polyp with a strongly developed siphonoglyph and reduced or no tentacles, usually much smaller than the autozooids, with the primary function of irrigating colonies with seawater

Spindles: straight or curved monaxial sclerites that are pointed at both ends

Stalk: the barren basal part of some colonies or the narrow proximal part of a non-retractile polyp

Stem: the main part of the colony, from which branches may or may not arise, or the polyp-bearing part of the colony, usually giving rise to the branches

Stolon: a rounded or flattened elongate or membranous coenenchymal expansion growing over the substrate and peripherally producing new polyps

Stoloniferous: colonies consisting of multiple polyps interconnected by stolons

Sulcal side: the side of a polyp nearest the siphonoglyph

Sympodial branching: the apparent main axis of the colony formed by the proximal parts of a series of shorter lateral branches (successive secondary axes) and having a zigzag or spiral form

Teeth: the more or less pointed lobes of the calicular margin, usually stiffened by sclerites, and typically numbering between two and eight when present

Thornstar: a type of flat sclerite in which one or more projecting thorns arise vertically from the middle of the divided, rootlike base and may be more-or-less leaflike; occurs in *Isidella tentaculum*

Trimorphism: in *Heteropolypus* only, the presence of three types of polyps (autozooids, siphonozooids, and mesozooids)

Variant: a subset of individuals of a particular species that deviates in form, typical anatomy, or behavior

Verrucae: wart-like projections

Warty club: a club (sclerite) with the head end ornamented with warts

Superfamily Pennatuloidea (Adapted from Bayer et al., 1983 and Dolan, 2008)

Acrozooid: large, white globular polyps clustered at the distal-most region of the ventral rachis in some shallow-water species of *Pteroeides*; they are presumably incipient vegetative buds and have an asexual reproductive function (Williams et al., 2012)

Anthocodia: the distal part of a polyp bearing the mouth and the tentacles

Asulcal side: the side of the polyp opposite the siphonoglyph

Autozooid: a polyp with eight well-developed tentacles and mesenteries; the larger polyp in dimorphic species, often termed simply "polyp" and typically responsible for food capture and reproduction

Axis: the calcareous inner supporting structure, sometimes called a rod, that in pennatuloideans is composed of high-magnesium calcite with very small amounts of low-magnesium calcite and aragonite

Calyces: cylindrical or wartlike projecting anthostele; some have between two and eight teeth and contain sclerites (as in *Balticina* and *Pennatula*)

Clavate: a club-shaped or terminally enlarged branch

Dorsal side: the side of the colony derived from the asulcal side of the oozooid; the side adjacent to the oldest (and often largest) autozooids in pennatuloideans having well-developed leaves

Dorsal track: the more or less naked strip extending along the rachis between the oldest polyps of the polyp leaves (corresponding to the asulcal side of the primary zooid)

End bulb: terminal (basal) swelling of the stalk

Longitudinal canals: the four main canals in some species formed by the gastric cavity of the primary polyp or oozooid, one dorsal, two lateral, and one ventral, extending the length of the colony

Mesozooid: a polyp intermediate in size and structure between autozooids and siphonozooids, found on the rachis and polyp leaves in some species of *Pennatula* and *Pteroeides*; apparently having an exhalent current function (Williams et al., 2012)

Oozooid: the primary polyp, also referred to as axial polyp, supported by the calcareous axis

Peduncle: the lower part of the colony devoid of polyps and polyp leaves, also referred to as the foot, that anchors in the substrate

Pentamorphic: possessing five types of polyps (oozooids, autozooids, siphonozooids, mesozooids, and acrozooids)

Polyp leaves: the flattened expansions bearing the secondary polyps

Rachis: the polypiferous (polyp bearing) part of the colony

Rays: radiating bundles of large sclerites on the underside of polyp leaves

Siphonozooid: a polyp with a strongly developed siphonoglyph and with reduced or no tentacles, usually much smaller than the autozooids, with the primary function of irrigating colonies with seawater

Stalk: the barren basal part of the colony above the peduncle or holdfast

Stipules: clusters of siphonozooids forming small accessory lobes at the dorsal ends of polyp leaves

Teeth: the more or less pointed lobes of the calicular margin, usually stiffened by sclerites, and typically numbering between two and eight when present

Terete: cylindrical but usually slightly tapered at both ends and with a smooth surface

Terminal polyp: the distal end of the primary polyp

Trimorphism: the presence of three types of polyps (autozoids, siphonozooids, and mesozooids)

Ventral track: the narrow naked strip extending along the rachis between the youngest polyps of the polyp leaves

Family Stylasteridae (Adapted from Cairns, 2011b)

Abcauline: on the side facing toward the growing tip of a branch

Adcauline: on the side facing away from the growing tip of a branch (see Fig. 16-5)

Ampulla (ampullae): the skeletal encasement of the gonophore, often forming a prominent hemispherical structure (see Fig. 16-2)

Anastomotic: forming a reticulate sieve

Branchlet: a smaller distal branch of a colony

Clavate: club-shaped

Coenosteum: the calcium carbonate skeleton of the stylasterid colony, usually aragonitic, but occasionally calcitic or partially calcitic

Corallum: the calcareous skeleton of the entire colony (sometimes called the colony)

Cyclosystem: a functional unit of some stylasterid genera in which a gastropore is surrounded by a circle of dactylopores (see Fig. 16-1)

Dactylopore: the surface pore of the stylasterid skeleton that is associated with a dactylozooid (see Fig. 16-2)

Dactylopore spine: a projection from the branch surface usually adjacent to a dactylopore, *U*-shaped or horseshoe-shaped in cross section (see Fig. 16-5)

Dactylostyle: a single row or crowded multiple rows of small cylindrical pillars that occur on the outer wall of the dactylopore tube and/or dactylopore spine

Dactylotome: the open area, usually a slit, which allows the dactylozooid to bend toward the polyp (see Figs. 16-3 and 16-4)

Dactylozooid: one of three types of stylasterid polyps that specializes in defense and food acquisition, each composed of a single mouthless tentacle

Dichotomous: bifurcating

Distichoporine: see **pore rows** and Fig. 16-2

Flabellate: fan-shaped

Gastropore: the surface pore (usually round) of the stylasterid skeleton that is associated with the gastrozooid (see Figs. 16-1 and 16-2)

Gastropore tube: the tube that contains the gastrozooid and, when present, the gastrostyle; it is usually a simple cylinder but may be double-chambered (see Fig. 16-4)

Gastrostyle: the vertical, spinose, axial structure that projects from the base of the gastropore tube of various genera (see Fig. 16-4)

Gastrozooid: one of three types of stylasterid polyps that specializes in obtaining food, usually consisting of a polyp having a ring of tentacles that encircle a mouth

Gonochoric: either male or female, not hermaphroditic

Gonophore: one of three types of stylasterid polyps that specializes in housing the reproductive gametes

Lamellate: composed of or arranged in layers

Lanceolate: in reference to a gastrostyle, narrow and tapered, like a lance

Linear-imbricate coenosteal texture: branch surface covered with linear parallel strips of imbricating scales (see Fig. 16-3)

Monotypic: a genus having but one species

Nematophore: large concentrations of nematocysts

Nematopore: a shallow skeletal pit in the coenosteum that houses a nematophore (see Fig. 16-3)

Papilla (papillae): conical, apically perforate nematocyst-bearing structures that occur on the coenosteum of some species

Porcellaneous: smooth and without pores

Pore rows: gastropores unilinearly arranged on branch edges, flanked on either side by a row of dactylopore spines; sometimes called a distichoporine arrangement (see Fig. 16-2)

Pseudocyclosystem: a semi-circular arrangement of dactylopore spines that resembles a cyclosystem

Pseudoseptum (pseudosepta): the roughly triangular-shaped coenosteum that separates the dactylotomes in a cyclosystem (see Figs. 16-1, 16-3, and 16-4)

Reticulate-granular coenosteal texture: branch surface covered with granular strips arranged in a reticulate manner (see Fig. 16-1)

Ring palisade: a ring or girdle of small cylindrical pillars that project from the wall of the gastropore tube near the level of the gastrostyles tip (see Fig. 16-4)

Supernumerary: additional, or extra, isolated dactylopores beyond those found in the cyclosystem (see Fig. 16-1)

Appendix II. Coral species reported from Alaska waters

This list includes the current known deep-sea coral species (Phylum Cnidaria, Class Anthozoa, and Class Hydrozoa) and their reported distribution and depth range in the 6 regions of Alaska: eastern Gulf of Alaska (1), western Gulf of Alaska (2), Gulf of Alaska Seamount Province (3), Aleutian Islands (4), Bering Sea (5), and Arctic (6). The list was drawn from historical collections, including specimens from the U.S. Fisheries Steamer *Albatross* expeditions and National Marine Fisheries Service stock assessment surveys, and past research expeditions. Single values in the depth range column represent depths known from only a single specimen or several specimens from the same location. The World Register of Marine Species was used as the taxonomic authority.

Higher taxon	Species	Distribution	Depth range (m)
Phylum Cnidaria			
Class Anthozoa			
Subclass Hexacorallia			
Order Antipatharia			
Family Cladopathidae	*Chrysopathes formosa* Opresko, 2003	1	619–756
	Chrysopathes speciosa Opresko, 2003	1	648–914
	Heteropathes pacifica (Opresko, 2005)	3	3563–4663
	Trissopathes pseudotristicha Opresko, 2003	3,4	2306–2828
Family Schizopathidae	*Alternatipathes mirabilis* Opresko and Molodtsova, 2021	3	4600–4685
	Bathypathes alaskensis Opresko and Molodtsova, 2021	1,3,4	329–1837
	Bathypathes patula Brook, 1889	2	4950
	Bathypathes ptiloides Opresko and Molodtsova, 2021	3	4491–4676
	Bathypathes tiburonae Opresko and Molodtsova, 2021	2	3280–3356
	Bathypathes sp. A	2	3275
	Bathypathes sp. B	3	4497
	Dendrobathypathes boutillieri Opresko, 2005	1,3,4	859–2161
	Dendrobathypathes sp.	3	1652–2634
	Lillipathes wingi Opresko, 2005	1,3,5	600–909
	Lillipathes sp. A	1,3	600–2738
	Parantipathes euantha (Pasternak, 1958)	3,4	862–2762
	Parantipathes pluma Opresko and Molodtsova, 2021	4,5	602–1562
	Parantipathes sp. A	3	2715–2819
Order Scleractinia			
Family Caryophylliidae	*Caryophyllia* (*Caryophyllia*) *alaskensis* Vaughan, 1941	1,4,5	90–1397
	Caryophyllia (*Caryophyllia*) *arnoldi* Vaughan, 1900	1,2,3,4	21–1702
	Crispatotrochus foxi (Durham and Barnard, 1952)	4	135–702
	Desmophyllum dianthus (Esper, 1794)	1	398
Family Dendrophylliidae	*Balanophyllia (Balanophyllia) elegans* Verrill, 1864	1	15–22
Family Flabellidae	*Flabellum* (*Flabellum*) *oclairi* Cairns, sp. nov.	4	27–507
	Javania borealis Cairns, 1994	4	17–1266
	Javania cailleti (Duchassaing and Michelotti, 1864)	3,4	150–2635
Family Fungiacyathidae	*Fungiacyathus* (*Bathyactis*) *marenzelleri* (Vaughan, 1906)	2,3	2370–6328
Family Micrabaciidae	*Leptopenus discus* Moseley, 1880	2	4820–5000
Order Zoantharia			
Family Epizoanthidae	*Epizoanthus scotinus* Wood, 1957	4	116

Appendix continued

Higher taxon	Species	Distribution	Depth range (m)
Family Parazoanthidae	*Mesozoanthus* sp.	1,2,5	123–625
	Zibrowius cf. *ammophilus*	3	745–2511
	gen. nov., sp. nov.	1	87–107
Subclass Octocorallia Order Malacalcyonacea			
Family Alcyoniidae	*Alcyonium pacificum* Yamada, 1950	4	6–12
	Alcyonium sp.	4	5–600
	Gersemia fruticosa (Sars, 1860)	2,4	1005–2564
	Gersemia lambi Williams, 2013	1	1–30
	Gersemia rubiformis (Ehrenberg, 1834)	1,2,4,5,6	3–90
	Gersemia sp.	3	897–1095
Family Clavulariidae	*Clavularia armata* Thomson, 1927	3	2667–2730
	Clavularia eburnea Kükenthal, 1906	4	715
	Clavularia rigida Broch, 1935	4	3277
	Clavularia sp. A	2,4,5	82–990
Family Gorgoniidae	*Callistephanus pacificus* Nutting, 1912	1,2,3,4,5	96–2778
	Callistephanus simplex (Nutting, 1909)	1,3,4	500–1352
Family Malacalcyonacea *incertae sedis*	*Alaskagorgia aleutiana* Sánchez and Cairns, 2004	4	87–1255
	Alaskagorgia splendicitrina Horvath and Stone, 2018	4	184
	Calcigorgia beringi (Nutting, 1912)	1,4	87–1933
	Calcigorgia gigantea Matsumoto et al., 2019	4	135–381
	Calcigorgia japonica Dautova, 2007	4	57–2210
	Calcigorgia matua Dautova, 2018	4	300
	Calcigorgia spiculifera Broch, 1935	1,4	12–512
	Cryogorgia koolsae Williams, 2005	4	18–412
	Elenanthus cf. *violaceus*	4	22–352
Family Paramuriceidae	*Acanthogorgia spissa* Kükenthal, 1908	4	1092–2087
	Acanthogorgia sp.	4	843–1692
	Muriceides cylindrica Nutting, 1912	4	393–881
	Muriceides nigra Nutting, 1912	4	78–1195
Order Scleralcyonacea			
Family Chrysogorgiidae	*Chrysogorgia* sp. A	4	1913–2514
	Chrysogorgia sp. B	3	3358–4768
	Chrysogorgia sp. C	4	1359
	Pseudochrysogorgia sp. A	3	1854–2227
	Pseudochrysogorgia sp. B	3	2787
	Pseudochrysogorgia sp. C	3	4103-4712
	Radicipes stonei Cordeiro et al., 2017	3,4	1612–3580
Family Coralliidae	*Hemicorallium* sp.	3	1677–1779
	Paragorgia jamesi Herrera and Shank, 2016	1,2,3	372–944
	Paragorgia arborea var. *pacifica* Verrill, 1922	2,3,4,5	21–1115
	Paragorgia arborea var. *pacifica* morph *nodosa*	2,3,4,5	299–2022
	Paragorgia stephencairnsi Sánchez, 2005	1,2,4	171–741
	Paragorgia sp. A	3	716–1112
	Paragorgia sp. B	3	730–1376
	Sibogagorgia cauliflora Herrera et al., 2010	3	2766

Appendix continued

Higher taxon	Species	Distribution	Depth range (m)
Subfamily Anthomastinae	*Heteropolypus japonicus* (Nutting, 1912)	4	400–424
	Heteropolypus ritteri (Nutting, 1909)	4	241–429
	Heteropolypus sp.	1,3,4,5	29–4216
	Pseudoanthomastus sp.	3	1122–2642
Family Keratoisididae	*Bathygorgia profunda* Wright, 1885	3,4	2372–4784
	Bathygorgia sp. A	3,4	603–1925
	Isidella tentaculum Etnoyer, 2008	1,2,3,4,5	115–1608
	Isidella sp. A	3	3839–4643
	Isidella sp. B	3	3909–4643
	Keratoisis sp. A	4	1584–2035
	Keratoisis sp. B	4	1716–2044
	Keratoisis sp. C	4	1715–1988
	Keratoisis sp. D	3	598–2689
	Keratoisis sp. E	3	3990–4373
	Keratoisis sp. F	1,4	574–1563
	Keratoisis sp. G	3	1689–1726
	Orstomisis sp.	4	2674–2826
Family Primnoidae	*Arthrogorgia kinoshitai* Bayer, 1952	4	150–1309
	Arthrogorgia otsukai Bayer, 1952	4	1332–1348
	Arthrogorgia utinomii Bayer, 1996	4	163–882
	Callogorgia compressa (Verrill, 1865)	4	82–1341
	Callogorgia fraseri (Hickson, 1915)	2,4	52–1341
	Calyptrophora laevispinosa Cairns, 2007	3	1754–3531
	Narella abyssalis Cairns and Baco, 2007	3	4559–4633
	Narella alaskensis Cairns and Baco, 2007	3	2216–3204
	Narella arbuscula Cairns and Baco, 2007	3	2710–3432
	Narella bayeri Cairns and Baco, 2007	2,3	3280–4092
	Narella cristata Cairns and Baco, 2007	3	3022–3358
	Parastenella doederleini (Wright and Studer, 1889)	4	1746–2539
	Parastenella gymnogaster Cairns, 2007	3	2193–3074
	Parastenella ramosa (Studer, 1894)	1,3,4,5	667–1937
	Plumarella aleutiana Cairns, 2011	3,4,5	79–2828
	Plumarella echinata Cairns, 2011	4	150–1692
	Plumarella hapala Cairns, 2011	4	120–407
	Plumarella nuttingi Cairns, 2011	4	350–888
	Plumarella profunda Cairns, 2011	4	2514
	Plumarella robusta Cairns, 2011	4	115–1061
	Plumarella spicata Nutting, 1912	4	712–1913
	Plumarella superba (Nutting, 1912)	4	40–715
	Primnoa pacifica Kinoshita, 1907	1,2,4,5	6–899
	Primnoa pacifica var. *willeyi* (Hickson, 1915)	1,2,3,4	27–863
	Primnoa wingi Cairns and Bayer, 2005	4,5	217–1280
	Thouarella cristata Cairns, 2011	4	91–744
	Thouarella trilineata Cairns, 2011	4	97–1266
Family Sarcodictyonidae	*Sarcodictyon incrustans* (Broch, 1935)	1	15–238
	Sarcodictyon sp. A	3	2665–2811

Appendix continued

Higher taxon	Species	Distribution	Depth range (m)
Superfamily Pennatuloidea			
Family Anthoptilidae	*Anthoptilum grandiflorum* (Verrill, 1879)	1,4,5	600–2511
	Anthoptilum murrayi Kölliker, 1880	3,4	744–2266
	Anthoptilum sp. A	3	898–1095
	Anthoptilum sp. B	3	797–1784
	Anthoptilum sp. C	4	1667–2707
	Anthoptilum sp. D	5	230–1116
Family Balticinidae	*Balticina californica* (Moroff, 1902)	1,2,4	35–823
	Balticina willemoesi (Kölliker, 1880)	1,2,4,5	18–310
	Balticina sp. A	1,2,4,5	253–1391
Family Kophobelemnidae	*Kophobelemnon* sp.	1	2869
Family Pennatulidae	*Pennatula aculeata* Danielssen, 1860	1,5	2869–2972
	Pennatula sp.	4	2239–2930
	Ptilosarcus gurneyi (Gray, 1860)	1,2,4	3–274
Family Protoptilidae	*Protoptilum* sp.	1,2	18–142
Family Stachyptilidae	*Stachyptilum superbum* Studer, 1894	4	388
Family Umbellulidae	*Umbellula* sp.	1,2,3,4	840–4656
Family Veretillidae	*Cavernularia vansyoci* Williams, 2005	4	94–126
Family Virgulariidae	*Virgularia bromleyi* Kölliker, 1880	5	1889
	Virgularia cf. *bromleyi*	1,2,4	20–472
	Virgularia cf. *glacialis*	4	122
Class Hydrozoa Order Anthoathecata			
Family Stylasteridae	*Crypthelia trophostega* Fisher, 1938	4	138–1913
	Cyclohelia lamellata Cairns, 1991	4	27–691
	Distichopora borealis Fisher, 1938	1,4	137–1361
	Errinopora dichotoma Lindner and Cairns, 2011	4	175–405
	Errinopora disticha Lindner and Cairns, 2011	4	176–536
	Errinopora fisheri Lindner and Cairns, 2011	4	455–458
	Errinopora nanneca Fisher, 1938	4	22–594
	Errinopora undulata Lindner and Cairns, 2011	4	366–425
	Errinopora zarhyncha Fisher, 1938	4	115–1520
	Stylantheca papillosa (Dall, 1884)	1	6–40
	Stylaster alaskanus Fisher, 1938	4	146–2124
	Stylaster brochi (Fisher, 1938)	1,2,4	20–455
	Stylaster campylecus (Fisher, 1938)	1,2,4	79–1396
	Stylaster crassiseptum Cairns and Lindner, 2011	4	291–531
	Stylaster elassotomus Fisher, 1938	4	881
	Stylaster leptostylus (Fisher, 1938)	4	518
	Stylaster parageus columbiensis Cairns and Lindner, 2011	1	88–439
	Stylaster parageus parageus (Fisher, 1938)	1,2	26–445
	Stylaster repandus Cairns and Lindner, 2011	4	375–650
	Stylaster stejnegeri (Fisher, 1938)	4	95
	Stylaster trachystomus (Fisher, 1938)	4	110–366
	Stylaster venustus (Verrill, 1868)	1	20
	Stylaster verrillii (Dall, 1884)	1,2,4	11–401

Appendix III. Additional supporting references on Alaska corals

Baco, A. R., and S. D. Cairns.
2012. Comparing molecular variation to morphological species designations in the deep-sea coral *Narella* reveals new insights into seamount coral ranges. PLoS ONE 7(9):e45555. https://doi.org/10.1371/journal.pone.0045555

Bright-Diaz, L. M., K. B. Strychar, and T. C. Shirley.
2011. Compounds from deep-sea bubblegum corals, *Paragorgia arborea*, elicit anti-predation behavior in fish. Open Mar. Biol. J. 5:58–67. https://doi.org/10.2174/1874450801105010058

Brugler, M. R., D. M. Opresko, and S. C. France.
2013. The evolutionary history of the order Antipatharia (Cnidaria: Anthozoa: Hexacorallia) as inferred from mitochondrial and nuclear DNA: implications for black coral taxonomy and systematics. Zool. J. Linn. Soc. 169:312–361. https://doi.org/10.1111/zoj.12060

Bryan, T. L., and A. Metaxas.
2007. Predicting suitable habitat for deep-water gorgonian corals on the Atlantic and Pacific continental margins of North America. Mar. Ecol. Prog. Ser. 330:113–126. https://doi.org/10.3354/meps330113

Cairns, S. D., R. P. Stone, E. A. Berntson, and S. A. Pomponi.
2017. Species discovery of deep-water corals and sponges in U.S. waters (2007–2016). *In* The state of deep-sea coral and sponge ecosystems of the United States (T. F. Hourigan, P. J. Etnoyer, and S. D. Cairns, eds.), p. 39–55. NOAA Tech. Memo. NMFS-OHC-4.

Cimberg, R. L., T. Gerrodette, and K. Muzik.
1981. Habitat requirements and expected distribution of Alaska coral. Final Report, Research Unit 601, VTN Oregon, Inc. U. S. Dep. Commer., NOAA, OCSEAP, Final Rep. 54:207–308.

Dunton, K. H.
2012. Chukchi Sea offshore monitoring in drilling area (COMIDA): chemical and benthos (CAB) final report. Bureau of Ocean Energy Management, OCS Study BOEM 2012-012, 311 p. [Available from https://espis.boem.gov/final%20reports/5182.pdf.]

Goddard, P., R. E. Wilborn, C. N. Rooper, K. Williams, and R. Towler.
2017. Results of the 2012 and 2014 underwater camera surveys of the Aleutian Islands. NOAA Tech. Memo. NMFS-AFSC-351, 505 p.

Heifetz, J., B. L. Wing, R. P. Stone, P. W. Malecha, and D. L. Courtney.
2005. Corals of the Aleutian Islands. Fish. Oceanogr. 14 (Suppl. 1):131–138. https://doi.org/10.1111/j.1365-2419.2005.00371.x

Heifetz, J., D. Woodby, J. R. Reynolds, and R. P. Stone.
2007. Deep sea coral distribution and habitat in the Aleutian Archipelago. North Pac. Res. Board Final Rep. 304, 303 p.

Heifetz, J., R. P. Stone, and S. K. Shotwell.
2009. Damage and disturbance to coral and sponge habitat of the Aleutian Archipelago. Mar. Ecol. Prog. Ser. 397:295–303. https://doi.org/10.3354/meps08304

Hoff, G. R., and B. Stevens.
2005. Faunal assemblage structure of the Patton Seamount (Gulf of Alaska, USA). Alsk. Fish. Res. Bull. 11:27–36.

Malecha, P. W., R. P. Stone, and J. Heifetz.
2005. Living substrate in Alaska: distribution, abundance, and species associations. Am. Fish. Soc. Symp. 41:289–299.

Miller, R. J., C. Juska, and J. Hocevar.
2015. Submarine canyons as coral and sponge habitat on the eastern Bering Sea slope. Global Ecol. Conserv. 4:85–94. https://doi.org/10.1016/j.gecco.2015.05.009

NMFS (National Marine Fisheries Service).
2011. U.S. national bycatch report. NOAA Tech. Memo. NMFS-F/SPO-117E, 508 p.
2013. U.S. national bycatch report, first edition update 1 (L. R. Benaka, C. Rilling, E. E. Seney, and H. Winarsoo, eds.), 57 p. Natl. Mar. Fish. Serv., U.S. Dep. Commer., Silver Spring, MD. [Available from https://www.fisheries.noaa.gov/resource/document/national-bycatch-report.]
2016. U.S. national bycatch report, first edition update 2 (L. R. Benaka, D. Bullock, J. Davis, E. E. Seney, and H. Winarsoo, eds.), 90 p. Natl. Mar. Fish. Serv., U.S. Dep. Commer., Silver Spring, MD. [Available from https://www.fisheries.noaa.gov/resource/document/national-bycatch-report.]

NOAA (National Oceanic and Atmospheric Administration).
2010. Report of the NOAA deep-sea coral and sponge ecosystems exploration and research priorities workshop for Alaska. Anchorage, AK, Sept. 14–15, 2010, 23 p. [Available from https://repository.library.noaa.gov/view/noaa/677.]

Reynolds, J. R., S. C. Rooney, J. Heifetz, H. G. Greene, B. L. Norcross, and S. K. Shotwell.
2012. Habitats and demersal fish communities in the vicinity of Albatross Bank, Gulf of Alaska. *In* Seafloor geomorphology as benthic habitat: GeoHAB Atlas of seafloor geomorphic features and benthic habitat (P. T. Harris and E. K. Baker, eds.), p. 539–553. Elsevier, London.

Rooper, C. N., M. E. Wilkins, C. S. Rose, and C. Coon.
2011. Modeling the impacts of bottom trawling and the subsequent recovery rates of sponges and corals in the Aleutian Islands, Alaska. Cont. Shelf Res. 31:1827–1834. https://doi.org/10.1016/j.csr.2011.08.003

Rooper, C. N., M. Zimmermann, M. M. Prescott, and A. J. Hermann.
2014. Predictive models of coral and sponge distribution, abundance and diversity in bottom trawl surveys of the Aleutian Islands, Alaska. Mar. Ecol. Prog. Ser. 503:157–176. https://doi.org/10.3354/meps10710

Rooper, C. N., M. F. Sigler, P. Goddard, P. Malecha, R. Towler, K. Williams, R. Wilborn, and M. Zimmermann.
2016. Validation and improvement of species distribution models for structure-forming invertebrates in the eastern Bering Sea with an independent survey. Mar. Ecol. Prog. Ser. 551:117–130. https://doi.org/10.3354/meps11703

Sigler, M. F., C. N. Rooper, G. R. Hoff, R. P. Stone, R. A. McConnaughey, and T. K. Wilderbuer.
2015. Faunal features of submarine canyons on the eastern Bering Sea slope. Mar. Ecol. Prog. Ser. 526:21–40. https://doi.org/10.3354/meps11201

Stone, R. P.
2005. Exploring deep-sea coral habitat on the edge—Alaska's Aleutian Islands. J. Mar. Educ. 21(4):18–21.

Woodby, D., D. Carlile, and L. Hulbert.
2009. Predictive modeling of coral distribution in the Central Aleutian Islands, USA. Mar. Ecol. Prog. Ser. 397:227–240. https://doi.org/10.3354/meps08358

SCIENTIFIC PUBLICATIONS OFFICE
NATIONAL MARINE FISHERIES SERVICE
7600 SAND POINT WAY NE, BLDG. 1
SEATTLE, WA 98115